NOVEMBER, 1946

THE WELDING ENGINEER

PIONEER TECHNICAL PUBLICATION OF THE WELDING INDUSTRY

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THE WELDING ENGINEER

THE WELDING ENGINEER, with which is consolidated The Acetylene Journal

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SEVEN YEARS AGO bronze welding saved the life of this 14-ton blank holder for a triple-action press. It stayed in service despite a few minor cracks and checks which later developed.

But recently, while forming turret tops for automobiles, a serious crack appeared and the valuable machine was down again. Once more it was Tobin* Bronze to the rescue: fractured on a Thursday, the holder was repaired and back in the plant the following Tuesday.

This was the score: 37 man-hours of chipping, 103 man-hours of welding, 600 lb. of Tobin Bronze.

This speedy rehabilitation job by the Super Arc Welding Co. of Detroit, is typical of the way low-temperature bronze welding saves valuable time and money in the reclaiming of worn, fractured or broken equipment. Applicable to cast iron, malleable iron, steel or copper alloys, bronze welding is also widely used in building up worn surfaces.

For detailed information on Anaconda Welding Rods, including Tobin Bronze and "997" (Low Fuming), write for Publication B-13. 46202

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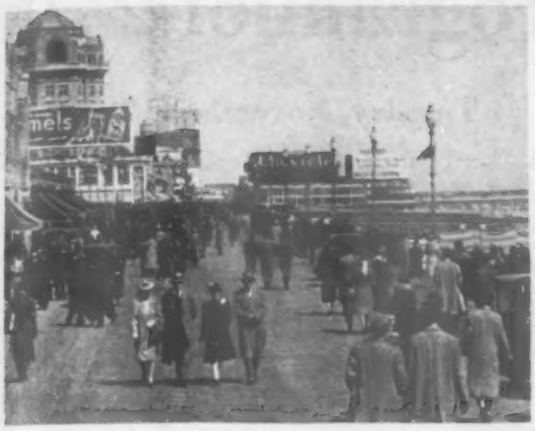


Annual AWS Meeting

Atlantic City and the Hotel Ambassador will be the meeting place for welding engineers and production men convening at the 27th annual meeting of the American Welding Society.

For the first time since 1941 the annual meeting of the American Welding Society will be of five days' duration and will be featured by social activities including a revival of the annual AWS banquet. During the Spartan days of the war, social activities were thrust aside to make room for concentrated thinking on the problems of war production and the use of welding in the war effort.

The forthcoming 27th annual AWS meeting will be held at Atlantic City, Nov. 17–22, with the Ambassador Hotel serving as convention headquarters. Postwar production uses of welding will be the principal theme of the 81 technical papers to be presented (see program on pages 40 and 41).

Other Societies Meet, Too

This year's welding convention will be held simultaneously with the 28th National Metal Congress and Exposition, further described on page 42 of this issue. Three other technical societies will meet during the same week: the American Society for Metals, headquartered at the Traymore Hotel, the American Institute of Mining and Metallurgical Engineers at the Hotel Claridge and the American Industrial Radium and X-Ray Society at the Seaside Hotel.

For AWS members, the week of activity will start with the president's reception on Sunday evening, Nov. 17, at Club 22 in the Ambassador Hotel. Officially, the meeting will be called to order Monday morning, Nov. 18.

Three simultaneous technical sessions have been scheduled for the Monday morning meeting. One of these will be devoted to weldability, and Professor Gilbert E. Doan will act as chairman. The other sessions of the morning will be a railroad session with A. G. Oehler as chairman, and an electrode session with J. H. Deppeler as chairman. Technical sessions of a simultaneous nature will continue on Monday afternoon and thereafter every morning and afternoon until Friday noon.

In addition to the weldability of materials, electrodes and railroads, the topics to be discussed will include research, (three sessions), production, storage tanks and pressure vessels, resistance welding, (four sessions), machinery, shipbuilding, flame-cutting, structural welding, the welding of alloy steels, pressure welding, aircraft welding, hard-facing and the welding of high alloys.

Annual Adams Lecture

The third annual Adams lecture will be given on Monday evening by Dr. Wendell F. Hess, of Rensselaer Polytechnic Institute. The other evenings will not be idle. The University Research Conference is scheduled to meet Tuesday evening, while welding society section officers will hold their annual dinner and meeting on Wednesday evening. The latter meeting is to include an open session on section operations involving the presentation of papers and discussion by section representatives.

The convention thus works up to its grand climax: the annual AWS banquet on Thursday evening. On this occasion presentation will be made of the various medals and awards such as the Samuel Wylie Miller medal, the Lincoln Gold medal, the RWMA prizes and the A. F. Davis undergraduate welding awards.

Delhi New President

The election and installation of the 1946–47 officers will take place at the business meeting, beginning at 2 p.m. on Friday afternoon. The new officers include W. L. Delhi, San Francisco, as president; H. O. Hill, Bethlehem, Pa., as first vice-president; and George N. Sieger, Detroit, as second vice-president.

Mr. Delhi, an Arizonan by birth and of Danish extraction, has long been active in promoting the interests of the American Welding Society on the Pacific Coast and has currently served as an AWS national director. He is vice-president of the firm of Hunt, Mirk and Co., San Francisco, a pioneer Bay Area firm of engineers and contractors.

Both Mr. Hill and Mr. Sieger will be re-elected to offices they have held during the current year. Mr. Hill is assistant chief engineer of fabricated steel construction, Bethlehem Steel Co., and Mr. Sieger is president and general manager of S-M-S Corp., a Detroit manufacturer of resistance-welding electrodes.

The business meeting of the Society will include the president's annual report and will be immediately followed by the annual meeting of the board of directors, bringing to a close what is believed will be a highly informative week of welding progress.

Program of 27th

Monday, November 18

9:30 A.M.—Simultaneous Technical Sessions

WELDABILITY

Chairman: GILBERT E. DOAN, Lehigh University. Vice-Chairman: CLARENCE E. JACKSON, Union Carbide & Carbon Research Labs.

"Cracking and Ductility in the Heat-Affected Zone of Metal-Arc Welds," by C. B. Voldrich, Battelle Memorial Institute.

"An Investigation of the Effect of Welding on the Transition Temperatures of Navy High-Tensile, Low-Alloy Steels," by G. G. Luther, R. E. Metius, C. E. Hartbower and F. H. Laxar, Naval Research Laboratory.

"Influence of Geometrical Restraint and Temperature on the Toughness and Mode of Rupture of Structural Steel," by A. R. Anderson and A. G. Waggoner, Cramp Shipbuilding Corp.

ELECTRODES

Chairman: J. H. DEPPELER, Metal & Thermit Corp. Vice-Chairman: J. H. HUMBERSTONE, Arcrods Corp.

"The E-601X Electrode Group," by Orville T. Barnett, Metal & Thermit Corp.

"Some Recent Developments in the Manufacture of Fluxes for Automatic Submerged-Arc Welding," by Dr. Willi M. Cohn, consulting engineer and physicist.

"Development and Application of Lime Ferritic Electrodes," by D. L. Mathias and A. P. Bunk, Metal & Thermit Corp.

RAILROAD

Chairman: A. G. OEHLER, associate editor, *Railway Age*. Vice-Chairman: J. W. SHEFFER, American Car and Foundry Co.

"Quantity Production of Railroad Passenger Cars by Resistance Welding," by A. M. Unger, Pullman-Standard Car Mfg. Co.

"Locomotive Boilers—Welded Construction," by James Partington, American Locomotive Co.

"Welded Freight Car Construction," by R. L. Rex, Air Reduction Sales Co.

2:00 P.M.—Simultaneous Technical Sessions

RESEARCH

Chairman: G. E. CLAUSSEN, Chairman, University Research Committee. Vice-Chairman: MARVIN SEDAM, Alloy Rods Co.

"Arc Atmospheres and Underbead Cracking," by M. W. Mallett and P. J. Rieppel, Battelle Memorial Institute.

"The X-Ray Diffraction Study of the Effect of Residual Compression on the Fatigue of Notched Specimens," by J. T. Norton, D. Rosenthal and S. B. Maloof, Massachusetts Institute of Technology.

"The Weldability of Ship Steels: Effects of Travel Speed, Preheat Temperature and Arc Power Level on Notch Toughness," by Ernest E. Nippes and Warren F. Savage, Rensselaer Polytechnic Institute.

"Some Observations on the Weldability of High-Strength Wrought Aluminum Alloys," by W. R. Apblett, Naval Research Laboratory.

PRODUCTION

Chairman: J. J. CHYLE, A. O. Smith Corp. Vice-Chairman: F. J. WHITNEY, JR., Heintz Manufacturing Co.

"Automatic Gas-Shielded Welding," by G. J. Gibson, Air Reduction Sales Co.

"Jigs and Fixtures for Automatic Fusion Welding," by L. J. Berkeley, Penn Tool and Machine Co., and E. D. Morris, The Linde Air Products Co.

"Tool and Die Welding," by A. R. Butler and Frank E. Kessler, Welding Equipment & Supply Co.

"Welding of Electric Apparatus," by E. F. Potter, Works Laboratory, General Electric Co.

STORAGE TANKS AND PRESSURE VESSELS

Chairman: H. O. HILL, Bethlehem Steel Co. Vice-Chairman: HARRY IRRGANG, W. K. Mitchell Co.

"Field-Erected Pressure Vessels," by Fred L. Plummer, Hammond Iron Works.

"Dry Seal Gas Holders, All-Welded," by Rudolf Kraus, Stacey Bros. Gas Construction Co.

"Submerged-Melt Welding in Pressure-Vessel Fabrication," by N. G. Schreiner, The Linde Air Products Co.

8:00 P.M.—Monday Evening—Adams Lecture

Chairman: J. D. GORDON, Progressive Welder Co. Vice-Chairman: W. G. THEISINGER, Lukens Steel Co.

Lecture by Dr. Wendell F. Hess, Rensselaer Polytechnic Institute.

Tuesday, November 19

9:30 A.M.—Simultaneous Technical Sessions

RESEARCH

Chairman: CHARLES H. JENNINGS, Westinghouse Electric Corp. Vice-Chairman: GEORGE G. LUTHER, Naval Research Laboratory.

"Computation of Cooling Time in Butt Welds," by D. Rosenthal, Massachusetts Institute of Technology.

"Effect of Peening on Residual Welding Stresses," by E. Paul DeGarmo, Finn Jonassen and J. L. Meriam, University of California.

"Welding of High-Strength Steels with Ferritic Electrodes," by S. A. Herres and P. E. Woodward, Watertown Arsenal Laboratory.

RESISTANCE WELDING

Chairman: R. E. POWELL, Western Electric Co. Vice-Chairman: B. L. WISE, National Electric Welding Machines Co.

"Flash Welding of Concentrated Areas up to 24 Sq. In. in SAE 1020, NE 9440, and NE 8620 Steels," by D. Bruce Johnston, McPhee and Johnston.

"Resistance Welding of Spring Steel to Low-Carbon Steel," by Arthur Willink, registered professional engineer.

"Design for Resistance Welding," by I. A. Crawford, Ex-Cell-O Steel Products Co.

MACHINERY

Chairman: L. S. MCPHEE, Whiting Corp. Vice-Chairman: A. J. RAYMO, Baldwin Locomotive Works.

"The Metallurgical Effect of Flame-Hardening Application," by O. M. Harrelson, Georgia School of Technology.

"The Evolution of Diesel-Engine Block Weldment Designs," by James W. Owens, Fairbanks-Morse & Co.

"Coördination of Engineering and Production in the Manufacture of Welded Products," by E. C. Brekelbaum, Harnischfeger Corp.

2:00 P.M.—Simultaneous Technical Sessions

RESEARCH

Chairman: JOHN W. GORE, Bethlehem Steel Co., Baltimore yard. Vice-Chairman: H. L. INGRAM, JR., Air Reduction.

"Redistribution of Residual Welding Stresses by Tensile Loading along a Submerged-Melt Weld Joining Two 3 Ft. by 12 Ft by 1 In. Plates," by J. L. Meriam, E. Paul DeGarmo and Finn Jonassen, University of California.

"Welding Research as Applied in the South," by W. W. Austin, Jr., and E. N. Kemler, Southern Research Institute.

"Welding of Hardenable Steels with High-Alloy (Austenitic) Electrodes," by Miss A. M. Turkalo and Capt. S. A. Herres, Watertown Arsenal Laboratory.

"An Investigation of the Phenomenon of Cleavage Type Fractures in Low-Alloy Structural Ship Steels," by H. J. Gershenow and G. G. Luther, Naval Research Laboratory.

RESISTANCE WELDING

Chairman: R. T. GILLETTE, General Electric Co. Vice-Chairman: GEORGE N. SIEGER, S-M-S Corp.

"Resistance Welding With Storage-Battery Power," by John D. Gordon, Progressive Welder Co.

"A Summary of the Spot Welding of High-Tensile Carbon and Low-Alloy Steels," by W. D. Doty and Wylie J. Childs, Rensselaer Polytechnic Institute.

"Selecting Spot-Welding Schedules for Low-Carbon Steel," by Julius Heuschkel, Westinghouse Electric Laboratories.

SHIPBUILDING

Chairman: H. W. PIERCE, New York Shipbuilding Corp. Vice-Chairman: T. M. JACKSON, Sun Shipbuilding & Dry Dock Co.

"Some Problems of Welding Design and Fabrication of Steel Floating Dry Docks," by A. Amirikian, Bureau of Yards and Docks, Navy Department.

"Control of Welding Stresses by Welding Sequence," by Paul Field, Shipbuilding Division, Bethlehem Steel Co.

"Discussion—Final Report of the Board to Investigate the Design and Methods of Construction of Welded Steel Merchant Vessels," by Comdr. R. D. Schmidtman, J. Lyell Wilson, and Finn Jonassen, members of the Sub-board.

8:00 P.M.—University Research Conference

AWS Meeting

Wednesday, November 20

9:30 A.M.—Simultaneous Technical Sessions

CUTTING

Chairman: JOHN J. CROWE, Air Reduction Sales Co. Vice-Chairman: A. B. GORDON, The Linde Air Products Co.

"Automatic Oxy-acetylene Operations," by S. D. Baumer, Air Reduction Sales Co.

"Heavy Cutting Applications in Foundry and Steel Mill," by R. S. Babcock, The Linde Air Products Co.

"Stainless Steel Cutting," by Howard Hughey, Air Reduction Sales Co.

RESISTANCE WELDING

Chairman: O. C. FREDERICK, General Electric Co. Vice-Chairman: JOHN CUMBERLAND, Arcway Equipment.

"Additional Timing Period of New Motor-Driven Control Increases Gun Welder Speed," by H. I. Stanback, Square D Co.

"Radiography and the Fatigue Strength of Spot Welds in Aluminum Alloys," by Robert C. McMaster and Horace J. Grover, Battelle Memorial Institute.

"Resistance Welding," a General Electric film to be shown by L. D. T. Berg, General Electric Co.

STRUCTURAL

Chairman: F. H. FRANKLAND, consulting engineer. Vice-Chairman: W. E. HENDRICKS, Belmont Iron Works.

"H-Section Welded Trusses," by A. T. Waidelich, The Austin Co.

"Welded Pier Leg, Shear Leg and Trolley of a 15-Ton Ore Bridge," by George F. Wolfe, Dravo Corp.

"Recent Trends in Concepts of Design for Welded Steel Structures," by LaMotte Grover, Air Reduction Sales Co.

2:00 P.M.—Simultaneous Technical Sessions

RESISTANCE WELDING

Chairman: K. W. OSTROM, K. W. Ostrom & Co. Vice-Chairman: E. S. ELWOOD, Taylor Winfield Corp.

"Choice of Cable and Transformer Size for Portable Spot Welder," by Myron Zucker, Mackworth G. Rees, Inc.

"Three-Phase Balanced Load Resistance Welding Machines," by Mario Sciaky, Sciaky Brothers.

"The Flash Welding of Hard-Drawn High-Carbon Steel Wire," by R. W. Bennett and R. D. Williams, Battelle Memorial Institute.

CUTTING

Chairman: J. H. ZIMMERMAN, The Linde Air Products Co. Vice-Chairman: JOHN D. BERT, Philadelphia Navy Yard.

"Arc-Oxygen Cutting on the Surface and Underwater," by Charles Kandel, Craftsweld Equipment Corp.

"Powder Cutting and Scarfing of Oxidation-Resistant Materials," by D. H. Fleming, The Linde Air Products Co.

"Some Recent Canadian Contributions to Oxygen Cutting" and film, "No Keener Blade," by R. A. Dunn, Canadian Liquid Air Co., Ltd.

"Oxygen Cutting of Steel at Elevated Temperatures," by J. F. Kiernan and J. S. Sohn, Air Reduction Sales Co.

WELDING ALLOY STEELS

Chairman: R. D. THOMAS, JR., Arcos Corp. Vice-Chairman: A. A. HOLZBAUR, Sun Shipbuilding Co.

"Investigation of the Weldability of Copper-Bearing Steels," by N. H. Keyser and C. H. Lorig, Battelle Memorial Institute.

"The Control of Weld Hot Cracking in Nickel-Chromium-Iron Alloys," by T. E. Kihlgren and C. E. Lacy, The International Nickel Co., Research Laboratory.

"The Development and Applications of High-Strength, Welding-Quality Alloy Steels," by Howard L. Miller, Republic Steel Corp.

"Navy-E.E.S. Method for Determining the Applicable Welding Procedures for Steels," by Bela Ronay, U. S. Naval Engineering Experiment Station.

8:00 P.M.—Section Activities

Chairman: F. W. DAVIS, chairman, Section Advisory Committee. Vice-Chairman: J. F. MAINE, past chairman, Cleveland Section.

Section Officers will hold their annual dinner and meeting at 6:30 p.m., to be followed by a special open session.

Thursday, November 21

9:30 A.M.—Simultaneous Technical Sessions

PRESSURE WELDING

Chairman: A. B. KINZEL, Union Carbide & Carbon Research Labs. Vice-Chairman: A. T. LIGHT, York Corp.

"Open Butt Oxy-acetylene Compression Welding," by H. H. Chiswik, Air Reduction Sales Co.

"Pressure Welding of Low-Alloy Steels and Some Non-Ferrous Alloys," by K. H. Koopman, Union Carbide and Carbon Research Labs., Inc.

"Pressure Welding Propeller Hubs and Stainless Steel Rings," by C. J. Burch, The Linde Air Products Co., and George Motherwell, Wyman-Gordon Co.

"Pressure Gas-Welding of Alloy-Steel Tubing," by Z. L. Zambrow and R. D. Williams, Battelle Memorial Institute.

AIRCRAFT

Chairman: G. S. MIKHALAPOV, Air Reduction Sales Co. Vice-Chairman: P. H. MERRIMAN, The Glenn L. Martin Co.

"Design and Production Control of Silver-Alloy-Brazed Joints in Aircraft Structures," by H. A. Smith and P. A. Koerner, Beech Aircraft Co.

"Resistance-Welding Test Methods Used to Maintain Quality in the Manufacture of the 140 Jet Engine," by P. G. Parks, Solar Aircraft Co.

"Welding Problems in Jet Propulsion—Stainless Steel," by E. J. DeWitt and Mr. Lammers, Wallace Supplies Mfg. Co.

HARD-FACING

Chairman: A. V. HARRIS, Haynes Stellite Co. Vice-Chairman: M. W. BREWSTER, Westinghouse Electric Corp.

"Repairing Contractors and Steel Mill Equipment with Manganese Application Bars," by L. A. Davis, Manganal Div., Stulz Sickles Co.

"How to Select Wear-Resisting Alloys for Welding," by Joseph A. Cunningham, J. A. Cunningham Equipment, Inc.

"Microstructure of Hard-Facing Alloys," by H. W. Sharp, Stoody Co.

"Composite Construction by Building up Surfaces with Submerged-Melt Welding," by J. E. Taylerson, The Linde Air Products Co.

7:00 P.M.—Thursday Evening—Dinner, Presentation of Medals and Prizes

Chairman: WENDELL F. HESS, president, American Welding Society. Vice-Chairman: E. V. DAVID, chairman, Convention Committee.

Friday, November 22

9:30 A.M.—Simultaneous Technical Sessions

HIGH ALLOYS

Chairman: R. D. THOMAS, SR., Arcos Corp. Vice-Chairman: E. R. MCCLUNG, Lukenweld, Inc.

"An Attempt to Select a Suitable Specimen for the Study of Corrosion Cracking in 18-8 Steel," by D. S. McKinney, Carnegie Institute of Technology.

"Welding and Other Fabrication Methods for Hastelloy Alloys," by C. G. Chisholm, Haynes Stellite Co.

"Effect of Alloying Elements on the Tensile Properties of 25-20 Weld Metal," by Hallock C. Campbell and R. D. Thomas, Jr., Arcos Corp.

MISCELLANEOUS

Chairman: H. B. SEYDEL, Air Reduction Sales Co. Vice-Chairman: G. R. JOHNSON, The Lincoln Electric Co.

"The Arc Welding of Cast Iron with Nickel Electrodes," by T. E. Hihlgren and L. C. Minard, The International Nickel Co., Research Laboratory.

"Static and Fatigue Tests of Arc-Welded Aluminum Alloy 61S-T Plate," by E. C. Hartmann, Marshall Holt and A. N. Zamboky, Aluminum Research Laboratories.

MISCELLANEOUS

Chairman: G. V. SLOTTMAN, Air Reduction Sales Co. Vice-Chairman: L. D. T. BERG, General Electric Co.

"Submerged-Melt Welding of Corrosion-Resisting Metals," by H. J. Roberts, The Linde Air Products Co., and R. J. Anderson, Dominion Oxygen Co., Ltd.

"Production Applications of Inert-Gas-Shielded Arc Welding," by H. T. Herbst, The Linde Air Products Co.

"A New Semi-automatic Arc Welding Process," by J. M. Tyrner Air Reduction Sales Co.

National Metal Exposition

THE 28th National Metal Exposition, to be held at the Municipal Auditorium, Atlantic City, during the week of November 18, will include a display of products and methods covering every phase of the metal-working industries. The keynote of this year's meeting will be education—an education that will be devoted solely to increasing productive output in the face of increasing labor and material costs. Many ideas for effecting this seemingly impossible feat will be depicted by means of ingenious displays, working models and, in some cases, actual demonstrations of how particular problems may be solved.

> Atlantic City is this year's host of the National Metal Congress and Exposition, which is being held in the East for the first time in five years.

One of the Largest

The second 1946 Congress and Exhibition is expected to be one of the largest in the 28 years of the history of this event. There will be more than 250,000 square feet of exhibit space, which will be devoted to classrooms, lecture halls, conference and display spaces. More than 400 exhibitors represent every branch of metal-working and associated industries.

The doors of the exposition will open at 12:00 noon on Monday and remain open until 10:30 in the evening. The same schedule will hold for Tuesday and Wednesday. On Thursday the exhibition will open at 10:00 a.m. and close at 6:00 p.m. to allow members of the participating technical societies to attend the annual banquets of their respective groups. The same hours will be held on Friday, with the exhibits finally closing at 6:00 p.m. that evening. Admission will be free to all members of the technical societies participating and to those holding invitations distributed by the exhibitors.

RWMA Joint Exhibit

All types of welding and flame-cutting on all kinds of metals will be included in the exhibits of some 50 or 60 firms in the welding industry. In addition to individual exhibits of the major companies in the welding field, the Resistance Welder Manufacturers' Association will sponsor a large coöperative exhibit in which 16 firms will demonstrate a wide variety of equipment.

In conjunction with the Congress, there will be held 18 educational lectures dealing with four important and timely metallurgical subjects. Five lectures each will be devoted to "Electronic Methods of Inspection of Metals," "Physical Metallurgy of Aluminum" and "Sleeve Bearing Metals." Three lectures will cover the subject, "The Structure of Cast Iron."

Of particular interest to the welding industry are the five lectures to be delivered on the electronic methods of inspection of metals. The methods to be covered include the strain gauge, spectrochemical analysis, Cyclograph, magnetic analysis, electron microscope, Sperry Reflectoscope and the Metalsorter.

A University of Metals

Thus gathered at one place at one time will be the outstanding authorities on the manufacture, production and fabrication of metals, a phase of industry vastly important to our peacetime production program. This five-day gathering might be likened to a great university with a faculty of thousands of technical and production wizards who are anxious to discuss, council and advise visiting students on how they can do more with what they have. It is expected that during the week some 50,000 persons will take advantage of this unique opportunity.

★ PRODUCTION

Production with Precision Flame-Cutting

Fig. 1—This part for a tire jack is precision flame-cut to a tolerance of plus or minus 1/64—0.01562 in.

BY FRED M. BURT

A West Coast job shop has developed into a major industrial enterprise by using the cutting torch for jobs that others figured could be done only in a machine shop. Tolerances to the thousandth of an inch in flame-cutting? This article will undoubtedly give you something to think about.

PRECISION flame-cutting has been developed to great versatility at Western Steel Cutting Works, Los Angeles. During the war this company was forced to build many of its own machines and work out its own production techniques on a variety of flame-cutting jobs. As it turned out, this necessity was a fortunate circumstance, for some of these machines were built especially to do many intricate precision-cutting jobs that would have been almost impossible to perform on orthodox machines.

CUTTING TO CLOSE TOLERANCES

To those whose experience with flame-cutting has been confined to hand cutting with an oxy-acetylene torch, cutting up metal for salvage or other rough work, or machine-cutting on jobs where 1/16 in. is considered a close tolerance, it is somewhat of a revelation to learn that tolerances of but a few thousandths of an inch can be obtained in fast production work. This statement is true not only with regard to simple rectilinear figures but also to curvatures, in the same or different planes. In Fig. 1, for example, the curved part for a tire jack is precision cut to ±1/64 in.

Fig. 2 shows typical examples of small units flame-cut in fast quantity production at costs much lower than they could be produced by any other method. All of

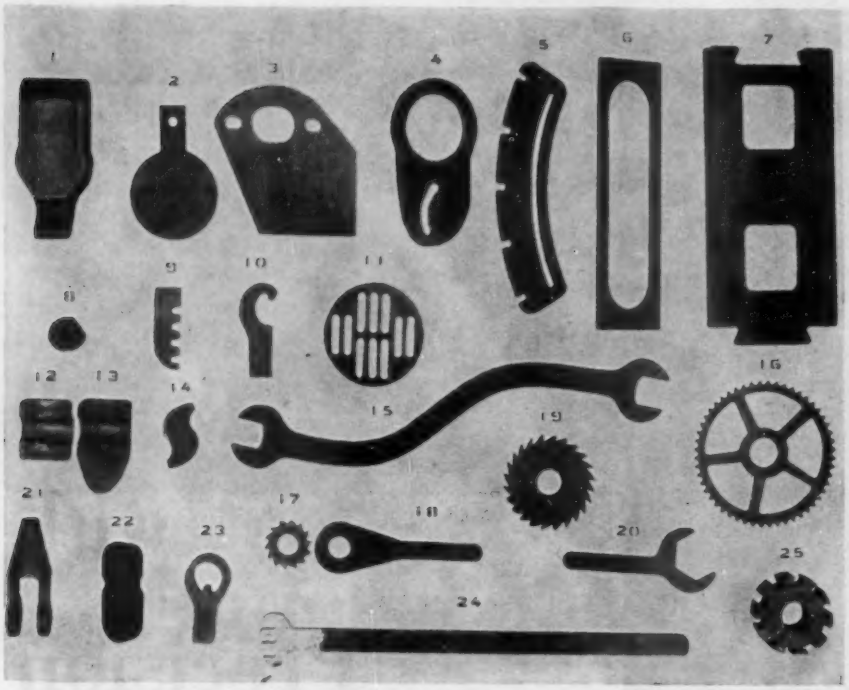


Fig. 2—All of these parts were flame-cut to final form in fast quantity production and required no subsequent machining except simple hole drilling in a few instances. See text for the explanation of the letters

these items were flame-cut to their final forms and required no machining (except simple hole drilling in a few instances). Each of these cutting jobs could be put into quick production as the only preliminary requirement was to make the comparatively simple template used to guide the torch.

25 Flame-Cut Parts

The numbers represent:

(1) A crosshead used as a tank-towing fixture.

(2) Line blind. Holes of varying sizes are drilled in these units, and they are inserted between the flanges at the ends of pipe lengths to change the size of the opening and consequently the rate of flow of the liquid carried.

(3) Bracket used on earth-moving equipment.

(4) Pump bracket.

(5) Lever guide to be used with a tractor ratchet handle.

(6) Hydraulic hoist plate (see also Fig. 4).

(7) Part of mold block to form interlocking concrete blocks used without mortar.

(8) A little boss used in large quantities on the famed "Water Buffalo" amphibious tank. This boss had been previously produced by milling at a cost of 3.2¢ each; it was flame-cut at 2¢ each.

(9) Part for tire-changing jack.

(10) Spanner wrench.

(11) Strainer plate.

(12) (13) Rod clamps.

(14) Brake cam used on army trucks. The contours and dimensions were held to within ¼-degree of relative curvatures.

(15) S-wrench used with earth-moving machinery.

(16) Bicycle sprocket.

(17) Ratchet.

(18) Ratchet handle.

(19) Ratchet.

(20) End wrench.

(21) Wire rope socket cut out of 2½-in. plate. These varied surfaces were made with three cuts.

(22) Chrome-moly steel linkage used in lifting B-29 bombers.

(23) Special wrench.

(24) Lever used on tire-changing machine (see also No. 9).

(25) Spline nut.

The thicknesses cut in these 25 items ranged from $\frac{3}{16}$ to 4 in., and tolerances on all but Nos. 1, 11 and 21 were kept at $\pm\frac{1}{64}$ in. The last three items only needed holding at about $\pm\frac{1}{16}$ in., but they were also kept close to $\frac{1}{64}$ in. Due to the methods of control employed, this presented little difficulty; it just occurred as a matter of course.

Most of the above parts were made of mild steel, but flame-cutting need not be confined to this material. Many steel alloys (of both high and low carbon steel) such as chrome-moly and chrome-vanadium are cut with equal ease; in fact, the higher carbon steels generally have a finer finish than mild steel. Speed and other machine adjustments are made, of course, to suit the type, size and shape of the metal.

Tanks into Plowshares

The old proposition of "beating swords into plowshares" has its modern counterpart in this plant. A large quantity of 11-gauge (3/32 in.) steel plate bought from the War Assets Administration and originally destined for use in tanks or other death-dealing devices is being cut—literally—into plowshares. These are stack cut, ten at a time. The contour of the plowshare measures about 54 in. and it takes about 8 minutes to trace it—a speed of approximately 7 in. per minute.

To start, the operator places the ten plates on the cutting machine table. He then takes a sheet-steel pattern of the finished plowshare and outlines on the top plate where the cuts are to be made. The plates are then clamped down as shown in Fig. 3. The torch, template and driving mechanism are suspended from a large adjustable framework projecting from a heavy vertical tubular post. The torch is guided in its close precision travel by a small spindle or contact roller that is magnetized so that it will closely follow the contour of the steel template.

In the plowshare job the template is suspended above the flame-cutting machine. This is likewise the case in Fig. 4. The part for a hydraulic hoist being cut in Fig. 4 requires a double template to provide for both inside and outside cuts.

Speeds on the company's nine shape-cutting machines are controlled by very finely wound rheo-

stats which are without speed steps, thus allowing a continuous variety of spindle speeds. For each job, the proper speed is determined by the thickness of the plate, the shape of the end product, the type of metal cut and other variables. Adjustments to meet all of these conditions are easily made by the operators, their decisions being based on experience and on the appearance of the cut as the tip progresses. Practically all cutting practices are covered within the ranges of the variables in the following table:

Flame-Cutting Mild Steel

Thickness of Steel, In.	Cutting Speed, In. per Min	Approx. Width of Kerf,* In.
¼	20–28	.050–.075
½	17–24	.065–.095
¾	15–22	.075–.110
1	14–19	.075–.110
1½	12–15	.085–.130
2	10–14	.105–.130
3	8–11	.120–.165
4	6.5–9	.135–.165
6	4.5–6.5	.135–.190
12	2.4–3.5	.260

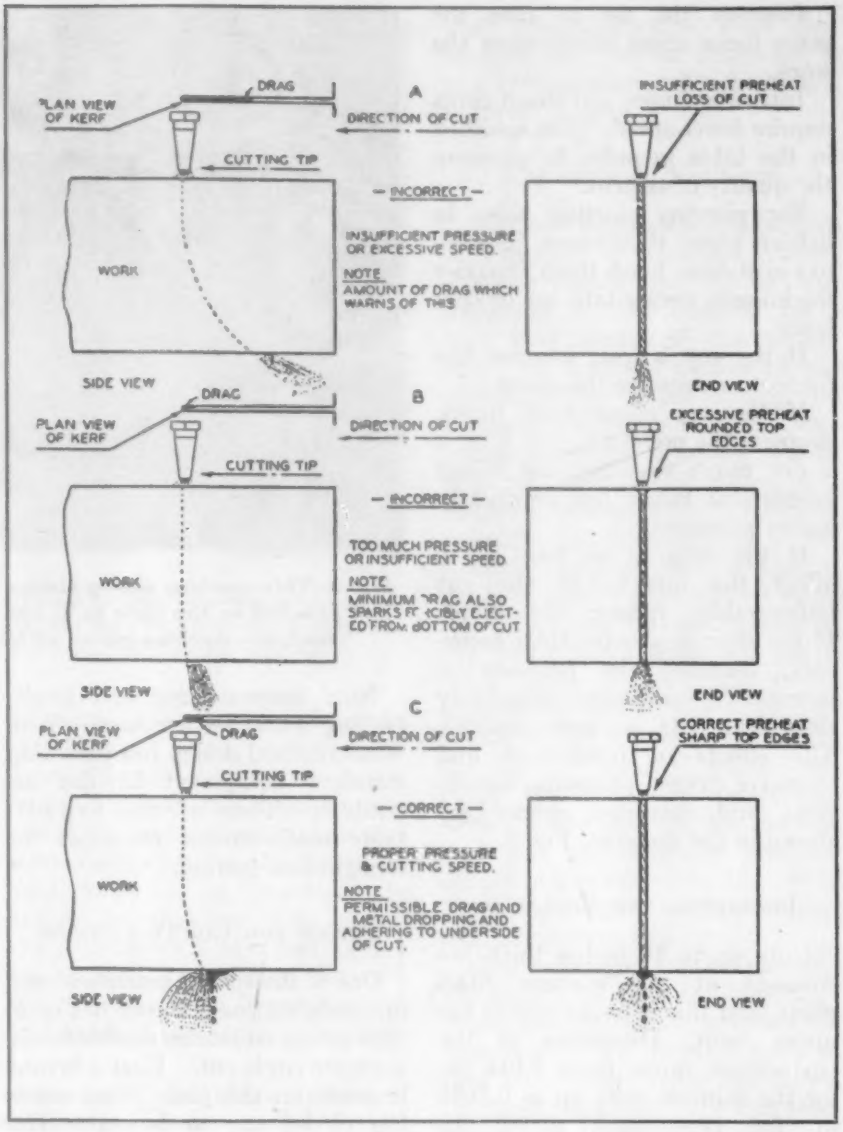
* Kerf is the width of the cut; the space previously occupied by the metal melted away.

Some other helpful hints:

When using oxygen hose of over 25-ft length, hose ⅜ in. ID will permit lower oxygen pressure than will hose 5/16 in. ID.

Keep tips clean with proper-sized cleaning drills or fibers.

Make final adjustment of regulator pressures with the torch valves open.



Courtesy, Air Reduction Sales Co.

Fig. 5—These sketches show the effects of insufficient pressure or excessive speed, too much pressure or insufficient speed, proper pressure and cutting speed. The drag should be neither too long nor too short

Fig. 3—Stack-cutting ten plowshares at a time from 11-gauge plate that was originally destined for war purposes. The template (not shown) is suspended above the torch, which is guided by a magnetized roller

Fig. 4—The roller follows the inner contour of the template to cut the outside of this hydraulic hoist part. The gentleman watching the operation is Harry Davis, field sales manager of Western Steel Cutting

Position the tip so that the inner flame cones barely clear the work.

Intricate shapes and sharp turns require lower speeds than specified in the table in order to preserve the quality of the cut.

For piercing starting holes in lighter plate thicknesses, use an oxy-acetylene hand torch; heavier thicknesses necessitate an oxygen lance.

If the cut is lost, increase the preheat or decrease the speed.

If the top edges melt down, decrease the preheat.

For rough severing, use higher speeds and larger tips or slightly higher pressures.

If the drag is so long as to affect the quality of the cut unfavorably, reduce the speed. If the drag is shorter than necessary, decrease the pressure or increase the speed since excessively short-drag cuts are uneconomical. The effects of insufficient and excessive oxygen pressures, insufficient and excessive speeds are shown in the sketches, Fig. 5.

Pressures and Fuel Gas

Cuts up to 10 inches thick are common at the Western Steel plant, and this is by no means the upper limit. Diameters of the tip orifices range from 0.018 in. for the thinnest cuts up to 0.1695 in. for very thick plates. In general, oxygen pressures range from 40 to 45 psi on plates up to 3 in. and from 45 to 85 psi on plates up to 12 in. The propane or butane gas used with the oxygen is held at pressures from 3 to 15 psi.

Propane or butane is used instead of acetylene because the latter is believed to have more of a hardening (carburizing) effect on the heated surfaces. If the cut unit requires a subsequent machining, the hardening that might come from the acetylene flame could necessitate an annealing operation. The propane or butane flame is not as hot as the acetylene flame and so requires a slightly longer time to preheat the metal. After the cut is once started, however, there is little difference in speed and effectiveness between the two flames, Western officials say.

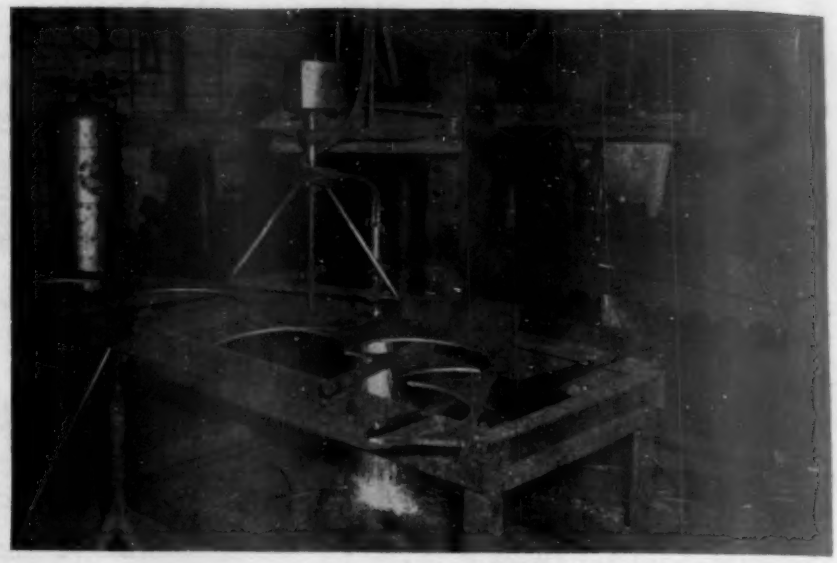


Fig. 6—This machine set-up always cuts perfect circles. A fixed center is first punched on the plate to be cut. If the metal "walks" because of the heat, the machine moves with it, maintaining a constant radius

Nine shape-cutting and circle-cutting machines are used, all of Western Steel design but including standard equipment in the assemblies. There are also five portable motor-driven machines for straight-line cutting.

Set-up for Circle Cutting

One of the special machines used for circle-cutting is shown in Fig. 6. This set-up maintains an absolutely accurate circle cut. First a layout is made on the plate from which the circles are to be cut. The center of the sheet-steel circular template is marked by a small hole, through which center holes are punched in the plate to be flame-cut. The sharp point of the vertical positioning rod is placed in the punched hole, and the cutting tip is positioned at the proper radius distance on the triangular supporting framework. Allowance is made, of course, for the kerf. The torch is then driven at the desired speed by the motor above the framework. As the cutting flame moves in its circular travel, the exact radius is maintained to make a perfect circle. Without the center positioning on the plate itself, there would be a more or less slight deviation from geometrical regularity when the metal "walked" because of outward expansion from the heat applied.

Another and more tricky application of circle cutting appears in Fig. 7, which shows the cutting of a large part for earth-moving equipment from heavy steel plate. The part measures 79 in. long, 18¾ in. wide and has 5½-in. diam circles flame-cut in each end and a 7-in. diam circle in the center portion. Four of these parts are used in each equipment, and it is of the utmost importance that all of the circles maintain the same dimensional relations to each other and to the outside cut.

The sheet-steel template is again mounted above the motor box, and the magnetized roller follows its contours to guide the cutting tip. The circles are cut first and then the outside outline. This procedure enables the proper dimensional relationships to be maintained between the outside cut and the edges of the circle and avoids difficulties due to the "walking" of the metal.

Caps for Contact Rollers

Variations in the cut down to the thousandth of an inch may be made quickly by the use of very thin caps over the roller that follows the template. If, for instance, a cut is 0.002 in. undersize, a cap with walls 0.001 in. thick is slipped over the contact roller to move it the proper distance out from the edge of the template. The contact

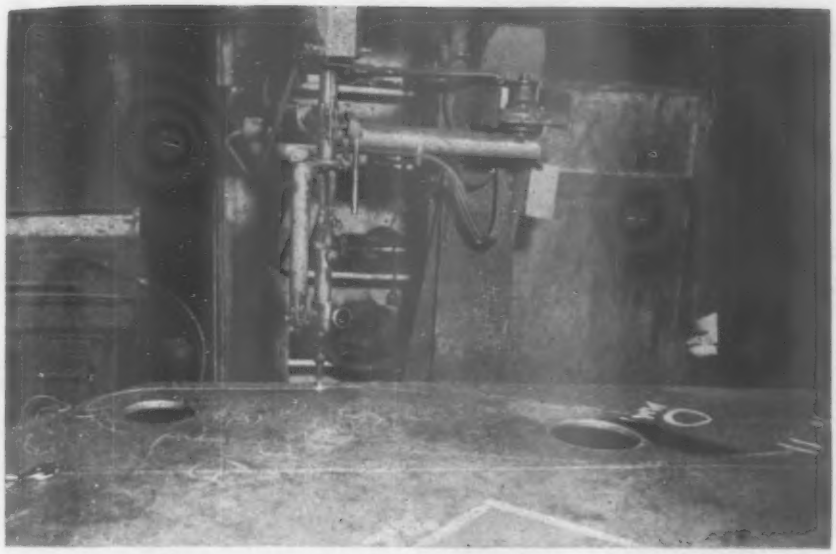
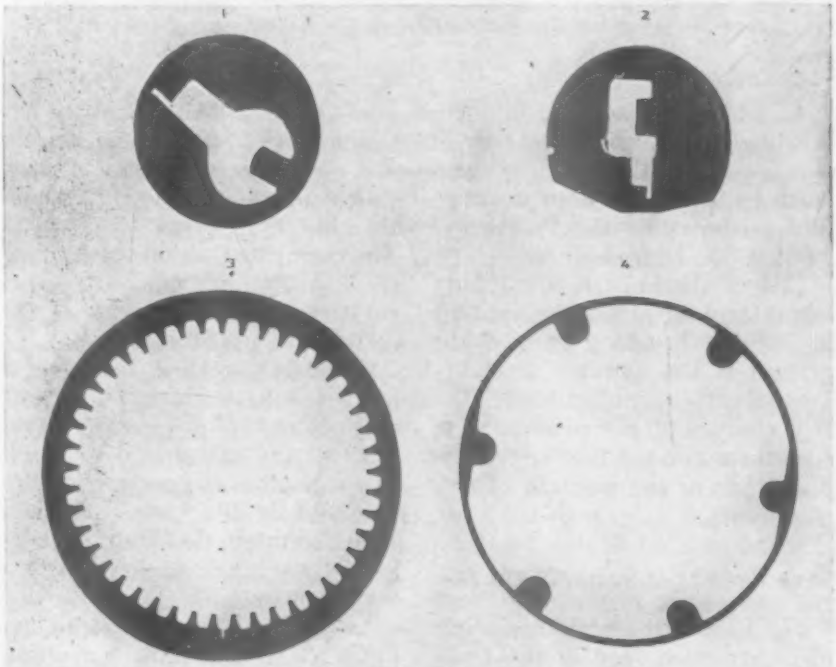


Fig. 7—Making the outside cut on a heavy part for earth-moving equipment, 79 by 18¾ in. The two 7-in. circles are cut first to avoid disturbing the dimensional relations between them and the outside outline

rollers are in graduated sizes (⅛-in. and ¼-in. ones are used most commonly), and there are caps of many different sizes to meet any requirement.

Field Sales Manager Harry Davis has a genuine job of sales engineering to do to determine whether or not the products of customers and potential customers lend themselves economically to the techniques of flame-cutting. In small lots, an item may be turned out more cheaply and quickly by machining, whereas a larger quantity can best be produced by making a template and then flame-cutting the parts to final form. It is important to know the dividing line. Again the pattern costs of a casting can be avoided by cutting the unit from a steel plate or cutting out and welding the component parts.

Fig. 8—Four typical templates (see text for explanation of the numbers). With all of these, the roller will follow the inside contours



Once the calculations show that an item can best be flame-cut, it is a comparatively simple matter to get it into production.

Making the Template

To make the production pattern or template, a steel-blue coating specially made for laying out templates is first brushed on a thin steel sheet of the proper size. An accurate outline of the part is scribed on the coating and the sheet is trimmed to this outline. The first pattern is merely a template to make a template; it is mounted on one of the machines to guide the flame-cutting of the working template from a heavier gauge of steel. The contact roller travels around the outer edge of the first pattern while the cut is being made to form the inside contour on the thicker steel. At Western Steel Cutting, it is always the inside contour which will guide the roller in production work. Allowance for the narrow kerf and provision for absolute accuracy is provided by the use of the proper-sized contact roller, with or without cap.

Four typical production patterns are shown in Fig. 8. Note that these templates are reverses or negatives of the finished part so that the contact roller can follow the inner contours. The four templates are for: (1) an open-end wrench, (2) a device to actuate a riveting operation (to be cut out of ⅞-in. chrome-moly steel), (3) an offcenter spur gear for a paper press (to be cut out of 2¾-in. plate to very close dimensions), (4) a porthole plate.

In flame-cut parts, it is important to lean toward the plus tolerance and avoid the minus. Too small a part is fit only for scrap, whereas any slight excess of material can be removed by grinding or filing. For this reason, units are flame-cut slightly on the plus side to allow for the necessary removal of surface metal.

In making one of the inside templates pictured in Fig. 8, the exact reverse is true. Extreme care must be taken that the cut shall not be on the plus side since this will mean a minus cut on the finished parts.

★ PRODUCTION

10,000 WELDS

OUTSTANDING for payload capacity and high safety factor are the new stainless-steel truck-trailers now being produced by Fruehauf Trailer Co., Fort Wayne, Ind., at the highest production rates ever known for such a product.

DESIGNED FOR GUN WELDING

From stem to stern, these trailers are designed for production by spot welding, employing mostly portable welding guns. There are actually some 10,000 welds in an average Fruehauf trailer. Obviously the time and equipment required to produce that many joints by bolting or riveting—even if an equal strength could be secured—would make construction impracticable or at least much more costly.

The basic principle of the welding process employed by Fruehauf is the Budd "shot-welding" process, which utilizes synchronous welding controls to control current flow. All of the welding guns used by Fruehauf were designed and produced by the Progressive Welder Co., Detroit.

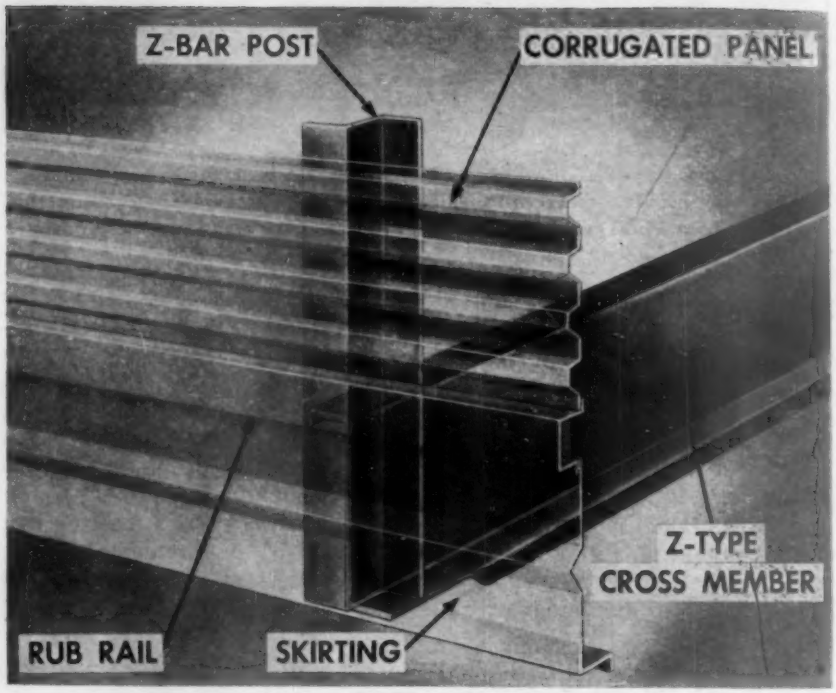


Fig. 1—Construction details of trailer frame. Note Z-bar vertical post and cross member and flat surfaces for spot welds on corrugated panel

Fruehauf Trailer Co. is able to turn out twenty completed stainless-steel truck trailers in each shift by designing them for resistance welding. And each of these trailers requires an average of some 10,000 welds—made mostly with portable welding guns.

One of the important corollary advantages obtained through the use of the Fruehauf gun-welding process is the extreme flexibility secured in the manufacturing. Design changes or the production of special sizes do not impose changes in welders or the securing of new equipment.

ALL STAINLESS-STEEL MEMBERS

Fig. 1 shows the general principle of construction used in the Fruehauf trailers. All members are stainless steel. Both vertical posts and cross members are Z-bars, which provide ready access for the insertion of welding guns. The corrugated stainless-steel panels have flat surfaces on the corrugations to receive welds of the correct size and strength.

Resistance welding is also used for the subassemblies of skirting and rub rail, of sides and vertical Z-posts, and of rub rail to panel. These various subassemblies are produced at the plants of Budd Manufacturing Co. and then delivered to Fruehauf for final assembly operations.

Assembly of the understructure, Fig. 2, is the first operation

MAKE A TRAILER

Fig. 2—Assembly of the underframe is the first operation on stainless-steel trailers at the Fruehauf Fort Wayne plant

Fig. 3—First assembly station jig. Small elevator at right is used when the nose section is welded to the side panels (see Fig. 6)

on the trailers at Fruehauf. As the spot-welded underframe travels down a conveyor, various members are attached to it to prepare it for assembling into the trailer body as a unit.

Fig. 3 shows the first assembly station jig. In this illustration note that the several types of welding guns are all suspended from overhead. This keeps the floor level clear inside the jig and also makes possible the handling of welding guns with a minimum of effort. At the right of the picture is a small elevator in which an operator rides when the nose section of the trailer is welded to the side panels (see Fig. 6).

The side panel subassemblies are dropped in place and locked with the quick-acting clamps shown in Fig. 4. Next the undercarriages are rolled in and dropped in place, being guided vertically by locating bars on the side panels. The front underframe and support assembly is now guided into position.

Spot Welding Cross Members

Accurate subassembling by welding is a major factor in eliminating the need for fitting and adjusting of these units as they are added to the trailer. Fig. 5 shows the first of the welding operations at Fruehauf. Here the cross members are being spot welded to the Z-bar uprights of the side section with a gun of the scissors type. "No-kick" concentric cables are used to insure easy handling and movement of the guns. For this welding operation, the jig is equipped with two types of right and left hand guns and one single gun (five in all). These guns, of course, are all of the heavy-duty hydraulic type to provide the pressures required to assure high-quality welds in stainless steel. The cross members are not clamped before welding since the gun itself pulls each member into accurate position. Attachment of the member to each post is by some 15 welds, made in rapid succession.

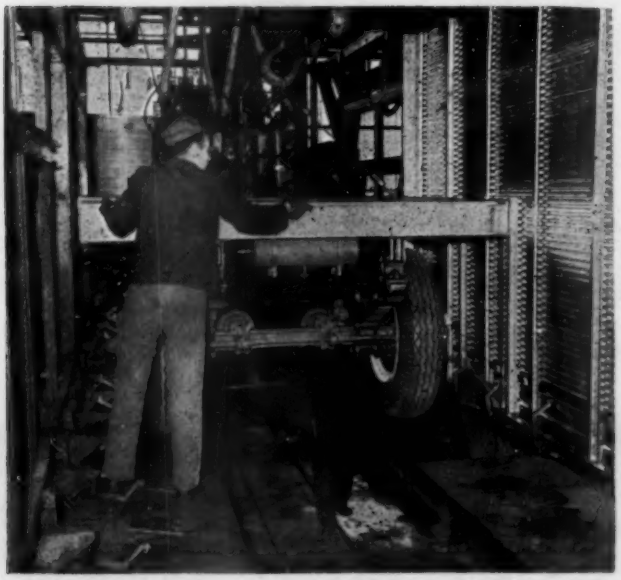


Fig. 4—The undercarriage is rolled in and dropped; the vertical locating bars guide the side panels to position. Quick-acting clamps hold the side panel assemblies

Fig. 5—Spot welding the cross members to the Z-bar uprights. A scissors-type welding gun is used here

Guns 100 Inches Long

Probably the most spectacular of the welding operations at Fruehauf is the welding of the nose section of the trailer to the side panels, as shown in Fig. 6. The guns used for this task have a 3-in. stroke and a throat depth of some 100 inches; they are believed to be the largest spot-welding guns ever produced. The ingenious design of these guns greatly simplifies the operation. Each gun is individually suspended from a ½-ton hoist and is lowered and raised electrically by the operator standing on the elevator shown outside the jig in Fig. 3. Copper bus-bars on the side of the stainless-steel gun jaws conduct the current from overhead transformers.

This operation involves approximately 180 welds on each side panel. To insure maximum strength, there are six welds on each corrugation. The bars shown suspended in the center of Fig. 6 are locators which clamp the nose piece temporarily to the side panels until the first welds have been made.

The use of the long-throat C-guns rather than the more conventionalized expansion gun makes

Fig. 7—Gun welding the floor stringers to the cross members. The lower jaws of the guns are inserted under the flanges of the Z-shaped cross members

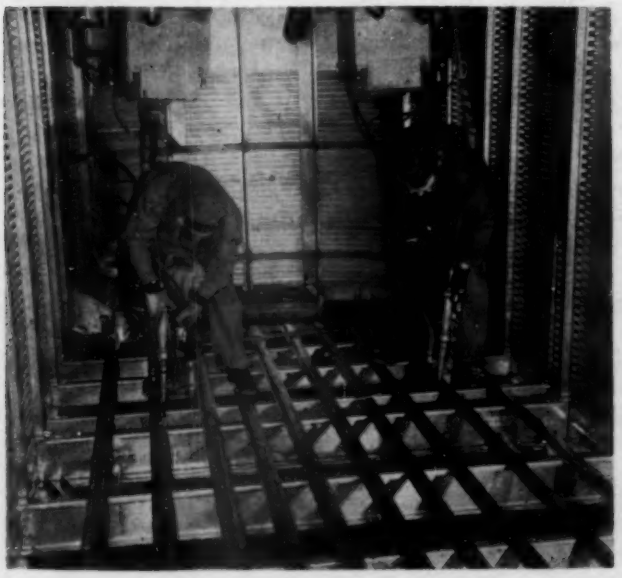


Fig. 8—The roof carlins are welded to the vertical Z-posts inside the trailer with scissors-type guns

possible the production of trailers of different sizes and shapes without change of equipment. Use of expansion guns would have necessitated provision of heavy copper plates to back up the panels in the jig, which would in turn have limited the amount of variation in trailer design possible to handle.

Adding Floor Stringers

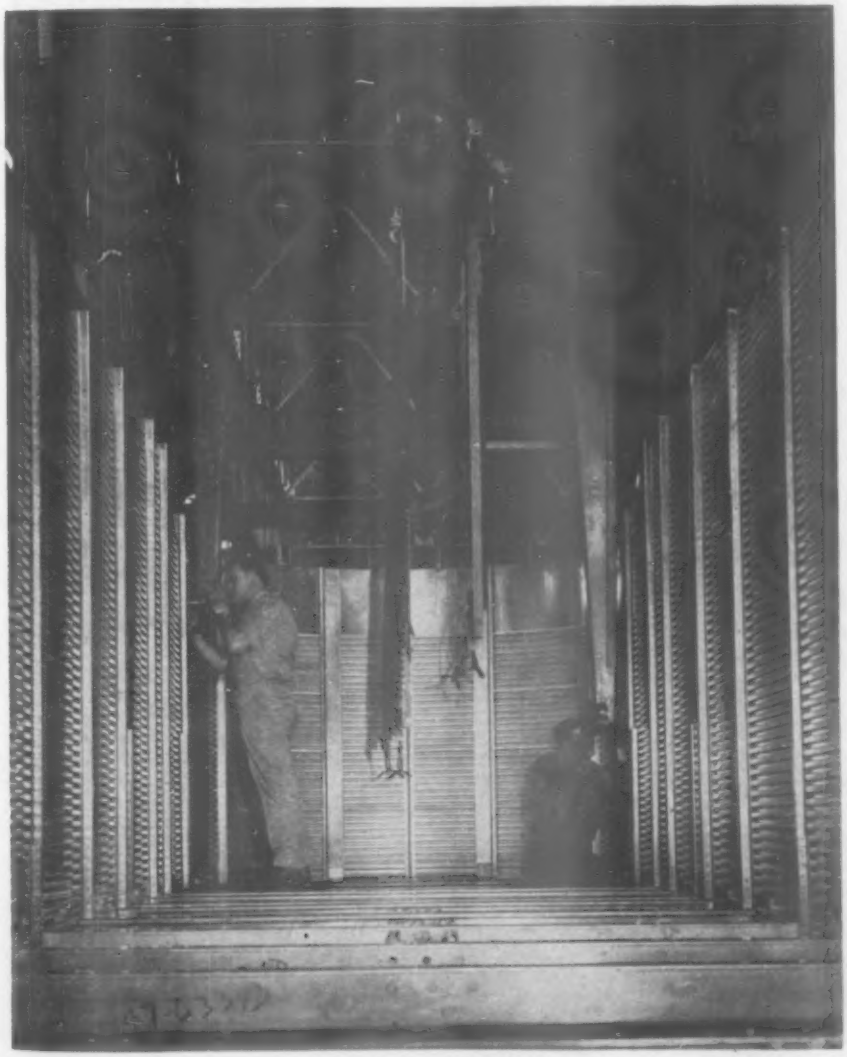
The trailer now moves to the second assembly fixture (Fig. 7), where ten flanged-channel floor stringers are gun welded to the cross members. Four welds are made at each intersection of the stringers. The C-type guns that are used to perform this task have their lower jaws inserted under the flanges of the Z-members. Transformers are overhead and move on tracks so that the operator is able to move the guns readily from one cross member to another. The transformers are equipped with hydro-boosters, similar boosters being used to close the jaws on all other guns used by Fruehauf.

In this station, also, the cross members are welded to the skirting. The latter operation is performed from underneath, using C-type guns with specially offset electrodes. The running gear and landing gear diagonals are likewise welded to cross members by using the C-type guns from below.

At the third assembly station, the "interior" welding guns and their equipment are mounted on a platform which is rolled into the trailer body. When retracted, the platform can be rolled sideways with its undercarriage to remove one trailer body from the jig and roll another into place. This is made necessary by the fact that in the third station the trailer is "boxed in" by welding the roof to the nose and side sections. Scissors-type guns are used for this operation, the welds being external. The flanges forming the joint also form the drip molding for the trailer.

A thyratron-type electronic control measures the quality of each weld. If welding conditions are not up to standard (as through a poor contact surface), a warning bell rings and the gun is automatically cut off until the condition has been corrected.

Fig. 6—Giant C-type guns having throats of 100 in. are employed to weld the nose to the side panels. These guns are lowered and raised by hoists



Inside Welding Equipment

Four welding guns are employed inside the trailer at the third station. Two of the scissors type are used to weld the roof carlins to the vertical Z-posts (Fig. 8), and two C-type guns weld the sleeper angle to Z-posts. Two other scissors-type guns located externally are used to weld the rear crossbeam to the door pillars.

The trailer is now ready for its final finishing operations. The hardwood floors are installed between the stainless-steel floor stringers with self-tapping screws, and the rear doors are assembled by means of a special supporting fixture to insure weathertight closure. A corrugated aluminum lining is also screwed on inside the interior.

Ten Trailers per Shift

The finished stainless-steel trailers roll down the line, ready for final inspection and delivery. The Fort Wayne plant now has two such lines, while another Fuehauf plant is being outfitted with similar equipment in Los Angeles. Through the use of resistance welding wherever possible, this progressive manufacturer is able to obtain a production of ten completed trailers per shift off each assembly line.

★ MAINTENANCE

Brazing an 1,174-lb Casting

By D. R. PETERSON

A broken Caterpillar drive gear case may be a tricky thing to repair, but a way was found to braze this one successfully.

THE shortage of replacement parts and crowded foundry conditions still make it virtually impossible to obtain new parts for construction equipment. This means that a contractor is often in real trouble when his equipment fails. Such was exactly the situation when a D-6 Caterpillar final drive gear case was broken in the Texas oil fields. To add to the problem, the cast-iron case had several long cracks and three loose pieces, two of which were missing. All of these difficulties were in the vicinity of the outboard axle bearing.

The best possible means of repairing this 1,174-lb casting seemed to be oxy-acetylene brazing, but it looked like too much of a job for R. B. George Co., Caterpillar tractor dealer, Lubbock, Texas, who accordingly shipped it to Peterson Welding Laboratories, Kansas City, Mo. Peterson Laboratories has specialized for many years in the welded repair of large castings, cylinder heads and blocks and has developed a patented procedure.

Edge Grinding, Alignment

The sketch, Fig. 1, illustrates the extent of the damage. One large piece, A-B-C-D, was completely cracked out. There was also a 2-ft crack on the back side of the casting from A to J to E. The piece from E to F and piece G were missing.

In preparation for brazing, piece A-B-C-D was removed and its edges ground to form a part of a vee varying from ¾ to 2 in. in width. The remaining part of the vee was, of course, formed by grinding the broken edges of the main casting.

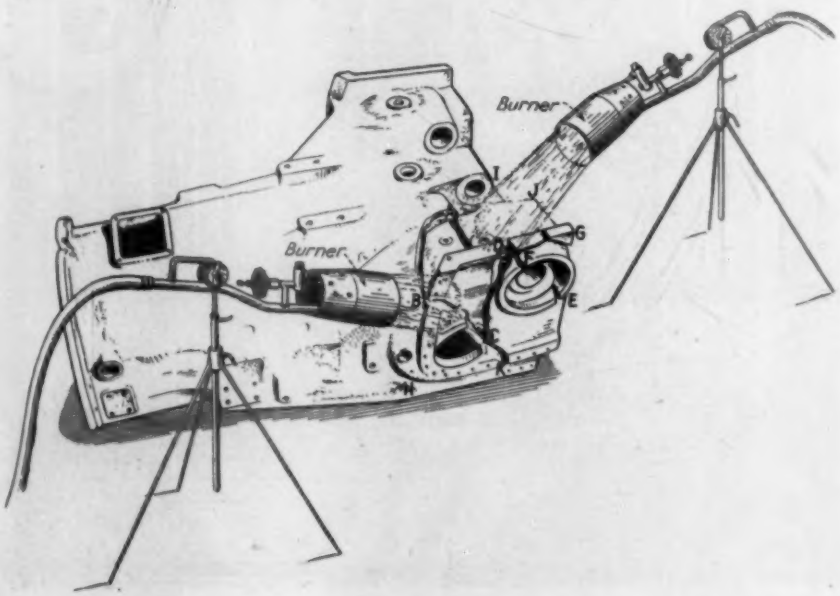
A length of 1 by 2 in. steel bar was heated and formed into a semicircle to make the missing piece of bearing race hub, E-F. Piece G was also made from the same material. The old and new pieces were aligned as shown in Fig. 2 and tacked in place with good, heavy 1-in. bronze tacks. A special low-heat flux and an ordinary bronze rod were used, and no preheat was necessary for the tacking.

Preheating the Casting

Since all of the brazing was confined to the corner from H to I, it was only necessary to preheat that corner. This was done by using two large kerosene burners, mounted as shown in Fig. 1. Each of these burners has an ID of 4⅛ in. and produces a soft, large flame.

The preheating was started at the farthest outside corner G and gradually extended on both sides of the casting until the whole corner from H to I had been raised to blue-black heat (about 550-600 F). The heat, of course, gradually tapered out into the rest of the casting. In doing this work, the operator found it necessary from time to time to pick up the burner on its tripod mounting and heat the heavier sections for a longer

Fig. 1—This sketch shows the broken pieces of the casting and method of mounting preheating torches. The letters are explained in the text



time. This tended to equalize the expansion of the thick and thin sections of the casting.

Naturally, the burners had to be taken away while brazing was going on, but they were restored during the two times that brazing stopped in order to keep the corner up to the proper blue-black heat.

Brazing Procedure

Using a 3/16-in. bronze rod, a low-heat flux and a torch with a No. 50 wire drill gauge tip (orifice diameter of 0.070 in.), one weldor started the brazing at A and continued down to B, then on to C. While this bead was being laid, a second operator followed it with a small-size kerosene burner and heated the entire bronze bead to a dark red. This prevented uneven contraction at the ends by allowing the bead to cool and contract uniformly.

The flux was applied by tinning an inch or two ahead of the main bronze bead. Another bead was now run from A to D to C to K. This bead also was followed up with a kerosene burner and brought to an even dark red before cooling. At the same time the helper with the burner also directed the burner over the entire casting to keep the heat from leaving the corner so that the blue-black temperature could be maintained. The whole corner was thus preheated a second time before brazing was continued.

The third step was to braze the back side of the casting from A around to E. The same brazing procedure was followed with the same heating of the entire bronze head. Since each bead was thus forced to contract evenly, the casting was kept in perfect alignment. The last cracks to be brazed were the outside edges of C to K and D to G.

A point to keep in mind: On a job like this, welding should be started at the inner end of a break and worked to the outer edges. This leaves the hot final heat at a corner or edge, where expansion and contraction are in the weldor's favor.

Reheating and Finishing

After brazing had been completed, a final reheat was made with the kerosene burners to bring the whole corner of the casting back up to a blue-black heat. This allowed all of the beads to close up and contract evenly as the casting cooled. The brazed deposits were all ground off to the level of the original casting.

The only machining operations required were on the two bearing race hubs; these were cut out with a flycutter. The casting was set on its side under a large drill press while the cutter lightly grazed the original part of the hub and cleaned up the added metal until the bearing race fitted accurately. No trouble at all was experienced in the assembly of bearings.

A gasket was used as a template for redrilling and tapping the holes that had been filled in during the brazing. The entire casting was then painted a Caterpillar yellow to give the appearance of a new casting. The finished drive gear case is shown in Fig. 3.

Time and Materials

This big job required some 47 man-hours of labor (total of both weldors, 1 finisher and 1 machinist). It used 35 lb of bronze welding rod, 3/4 lb of low-heat brazing flux, 8 gallons of kerosene and three hours' consumption of oxygen and acetylene with a No. 50 wire drill size welding tip.

The essential work on this repair was done before the actual brazing started. The four key points to keep in mind are:

(1) Large, heavy bronze tacks were used to tack the pieces together. Needless to add, proper alignment had to be secured first.

(2) Preheating was localized on the corner of the casting, tapering off into the main body.

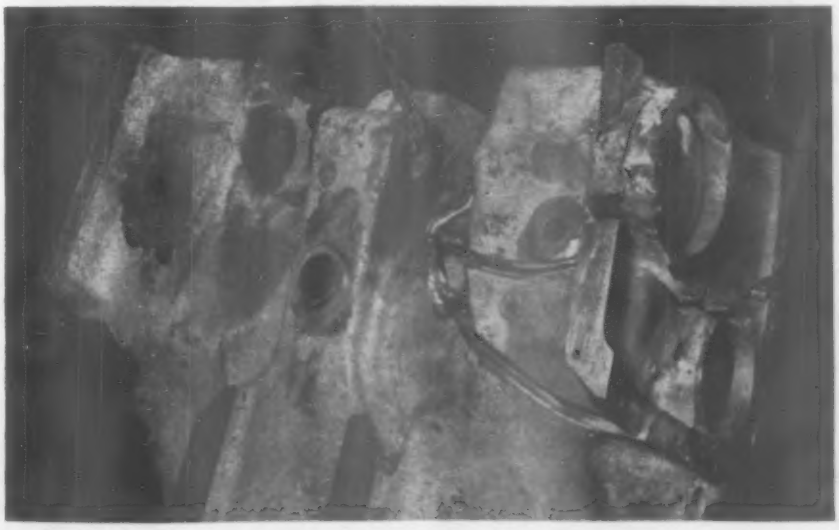
(3) Two large soft-flame kerosene burners preheated the casting evenly.

(4) A good strong bond was obtained by the use of the special low-heat flux.

At last report from the R. B. George Co., the repaired casting was still in satisfactory operation after three months of service.

Fig. 3—The finished job. It looks and acts like a new casting

Fig. 2—The pieces aligned for brazing with vees ground along the edges



★ RESEARCH

Welding Methods for Alloy-Steel Piping

★ Part Three—Chromium-nickel or stainless steels, widely used because of their corrosion resistance, introduce some perplexing problems in welding. Mr. Seabloom tells here how they should be handled.

Tremendous strides have been made in applying welding to the fabrication and assembly of piping systems. Because of the increasingly severe operating conditions being imposed on piping, welding has become almost a necessity to overcome the difficulties that are experienced with most mechanical joints.

To meet the requirements of adverse operating conditions, more alloy steels will be employed. The various grades of chromium-molybdenum, straight-chromium and chromium-nickel steels, though not as readily weldable as plain-carbon steels, can be successfully joined in both shop and field by various welding methods. However, a knowledge of the behavior of these steels under welding heat is necessary to enable proper procedures to be drawn up.

In a series of four articles appearing in THE WELDING ENGINEER, *Mr. Seabloom discusses the techniques generally employed and the cautions to be observed in dealing with the alloy steels. The two previous articles covered the chromium-molybdenum and the straight-chromium steels. The present article deals with the welding of the chromium-nickel stainless types, and the final article will cover soldering and brazing methods*—THE EDITORS.

A VERY important group of chromium steels are those containing nickel plus other elements to a lesser degree. These are known as the austenitic chromium-nickel stainless types, although all of them are not austenitic. Nickel, added in sufficient amounts, renders the steels austenitic and non-magnetic and gives improved ductility and toughness as compared to the straight-chromium steels. Most of the chromium-nickel steels are classified by the American Iron and Steel Institute; the more important ones are tabulated in Table I.

Outstanding in their resistance to corrosion and oxidation, these steels also display excellent physical properties at both subzero and elevated temperatures. Corrosion, however, often introduces many perplexing problems, and the ultimate choice of material must depend upon fairly definite information regarding the conditions under which the equipment is to be used and the results that are expected from it.

Table I. Analyses of Most Widely Used Stainless Steels

AISI Type	Popular Name	Carbon Content	Chromium Range	Nickel Range	Other Elements
302	18–8	0.08–0.20	17.00–19.00	8.00–10.00	Mn 2.00 max.
304	19–9	0.08 max.	18.00–20.00	8.00–10.00	Mn 2.00 max.
308	19–9	0.08 max.	19.00–22.00	10.00–12.00	Mn 2.00 max.
309*	25–12	0.20 max.	22.00–24.00	12.00–15.00	Mn 2.00 max.
310*†	25–20	0.25 max.	24.00–26.00	19.00–22.00	Mn 2.00 max.
316*	18–12–2	0.10 max.	16.00–18.00	10.00–14.00	Mo 2.00–3.00 Mn 2.00 max.
317	19–14–3	0.10 max.	17.50–20.00	10.00–14.00	Mo 3.00–4.00 Mn 2.00 max.
321	19–9ti	0.10 max.	17.00–19.00	8.00–12.00	Ti 4 x C min. Mn 2.00 max.
329	25–3–1½	0.20 max.	23.00–25.00	2.50–5.00	Mo 1.00–2.00
347	19–9cb	0.10 max.	17.00–19.00	8.00–12.00	Cb 8 x C min. Mn 2.00 max.

* *Welding rod available with columbium additions.*
† *Welding rod available with molybdenum additions.*

WELDABILITY CHARACTERISTICS

Most of the austenitic chromium-nickel steels are readily weldable by the processes generally employed in fabrication and erection of piping: oxy-acetylene, atomic-hydrogen and metal-arc welding. Welds in most of these alloys are strong, ductile and tough in the as-welded condition. Postweld heat treatment does not improve physical properties, but it is a requisite

This metallographic microscope in the Crane Research Laboratories is used to study structures of stainless steels after exposure to temperature, as during welding, brazing and/or heat treatment and in corrosive service

BY ERIC R. SEABLOOM
Supervising Engineer, Crane Co. Research Laboratories

on some alloys to obtain maximum corrosion resistance, as will be later explained.

All of these steels have certain characteristics which must be taken into account when they are welded. The chief ones are:

(1) The coefficient of thermal expansion is about 50% greater than that of plain-carbon steels; consequently, distortion and warpage may become a problem. The greater expansion can generally be taken care of by adequate spacing of the welding groove openings.

(2) The thermal conductivity is about 50% less than that of plain-carbon steels; hence heat is retained longer and the work cools off more slowly. Since the heat conductivity is low, localized high-temperature areas adjacent to the welds will be encountered. When these are combined with the effect of high thermal expansion, greater distortion usually occurs.

(3) The melting points of stainless steels are slightly lower than those of plain-carbon steels; thus somewhat less heat is required to make welds.

(4) The electrical resistance is about six to twelve times that of plain-carbon steel; this means, obviously, that lower currents can be employed in arc welding.

(5) These alloys, as a rule, do not respond to heat treatment. Usually, they cannot be hardened or grain growth (due to high welding heats) cannot be reduced except by cold working.

Carbide Precipitation

The structural stability of most austenitic chromium-nickel steels is affected by heat. When they are subjected to temperatures between 800 and 1,600 F, as during welding or in service, these steels undergo a structural change. Carbon migrates out from solid solution and combines with the chromium-forming chromium carbides along the grain boundaries, as illustrated in B of Fig. 1. This effect is known as carbide precipitation, and it impoverishes the chromium content adjacent to the grain boundaries, increasing susceptibility to corrosive attack. Carbide precipitation thus leads to what is generally referred to as intergranular corrosion, shown in Fig. 2.

Carbide precipitation is influenced by several factors. The longer the metal is held within the range of 800–1,600 F, the more carbides will precipitate; the closer to 1,200 F the temperature is maintained, the more undesirable will be the structural change. Higher carbon contents increase the formation of carbide precipitates since there is more carbon to combine.

In handling mildly corrosive media in a piping system, carbide precipitation may be of minor importance, especially if the carbides at the grain boundaries are present in only a small amount. High stresses will increase the susceptibility to corrosion. If highly corrosive agents are being conveyed, severe attack may occur even though stresses are low.

Carbide precipitation can be corrected by heat treatment. This is accomplished by heating the metal to about 1,950 F for a sufficient period of time to redissolve the carbides and allow them to go back into solution. The heating is then followed by quick cooling to below 800 F (see A of Fig. 1). The cooling cycle should be rapid through the 1,600 to 800 F range to avoid the possibility of carbides reforming.

In many cases pipe fabrications cannot be subjected to such drastic heat treatment, and in field erection it is practically impossible to follow such a procedure. Fortunately, it is not always necessary to heat treat since in many installations the corrosive environment is relatively mild. A fair degree of corrosion resistance can be accomplished by selecting a welding method that minimizes the time of heat application.

Effects of Stabilizers

Referring back to Table I, it will be observed that some of the steels have additions of columbium or titanium. Such additions, known as stabilizers, tend to combine with the carbon to retard the formation of the objectionable grain-boundary chromium carbides. Titanium is not as effective in the welding rod as in the base metal because much of this stabilizer is lost during the transfer of metal from the rod to the work. The recovery of columbium in the welding process is more satisfactory.

In making weldments with columbium-stabilized materials, the weld and heat-affected zones can

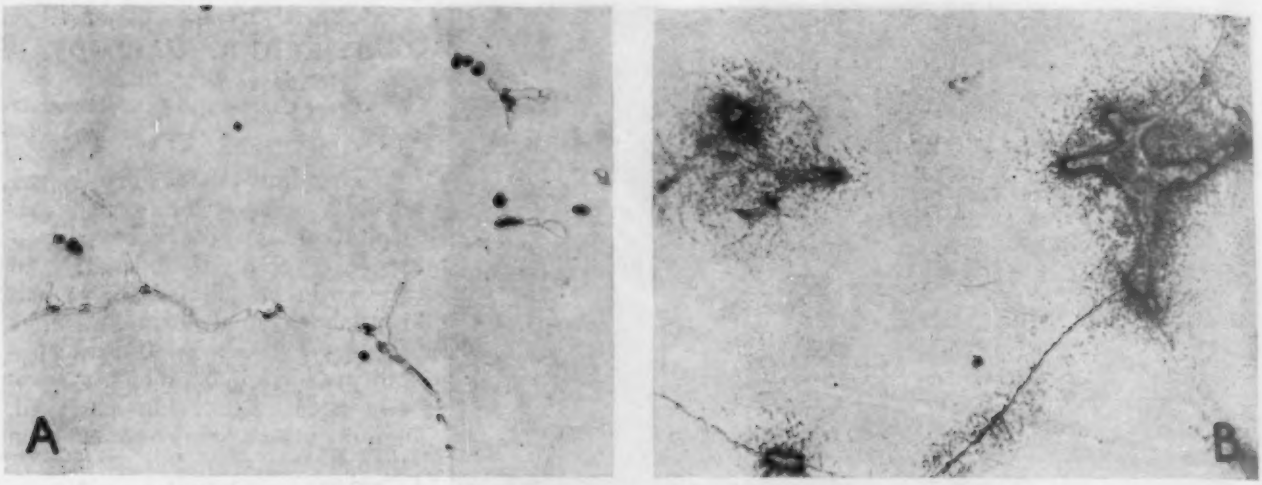


Fig. 1—Photomicrographs at 400 X of austenitic stainless steel illustrating: (A) normal structure as quenched from 1,950 F; (B) carbide precipitation at grain boundaries and delta ferrite after 4,000 hours at 1,200 F

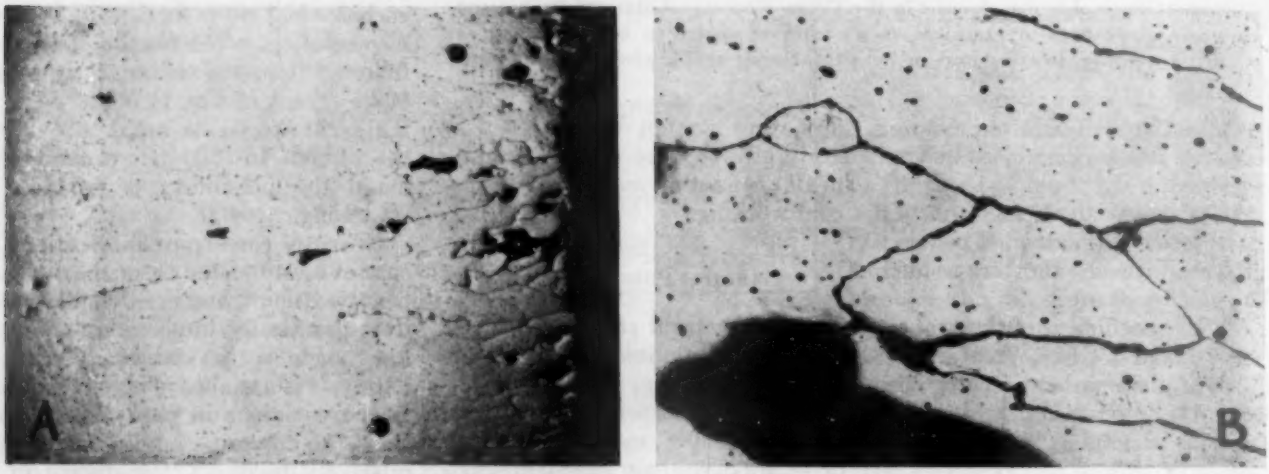


Fig. 2—Intergranular corrosion of austenitic stainless steel from high-temperature service. (A): Macrograph at 10 X shows breaking out of grains (sugaring). (B): Photomicrograph at 40 X shows voids along grain boundaries

pass through the heat-sensitizing range of 800–1,600 F without too much danger of carbide precipitation; consequently, heat treatment can often be dispensed with. When proper procedures are followed, welds in chromium-nickel steels will display high strength, great toughness, ductility and complete soundness, meeting the requirements of the ASME Boiler Code and the ASA Code for Pressure Piping on procedure and operator qualification tests.

Oxy-acetylene Welding

The austenitic chromium-nickel stainless steels can be welded by the oxy-acetylene flame. The process, however, is most applicable to tubing of lighter wall thickness. With thicker piping, the greater spread of heat and longer heating time needed for melting are apt to cause distortion and carbide precipitation. Oxy-acetylene welding finds its widest usage with smaller-diameter, light-gauge, columbium-stabilized tubing.

Generally, the welding tip should be one or two sizes smaller than the one that would be used for plain-carbon steel piping of comparable dimensions. A neutral flame is preferred. An oxidizing flame should be avoided since chromium oxidizes readily and will be burned out. A reducing flame is also undesirable as it increases the carbon content of the weld. Regardless of flame adjustment, it is essential to employ a flux, applied to the welding grooves and rod, as chromium oxidizes easily when molten. Several special fluxes are marketed for this purpose, and chromium oxides can be materially reduced when the proper flux is combined with a minimized puddling of the metal during deposition.

In order to obtain the best corrosion resistance in the deposited metal, it is desirable to select welding rods that contain slightly higher percentages of chromium, manganese and silicon than the base metals to allow for the reduction of these elements in the welding flame.

The welding grooves recommended are the single-vee butt joints, fillet or socket joints and

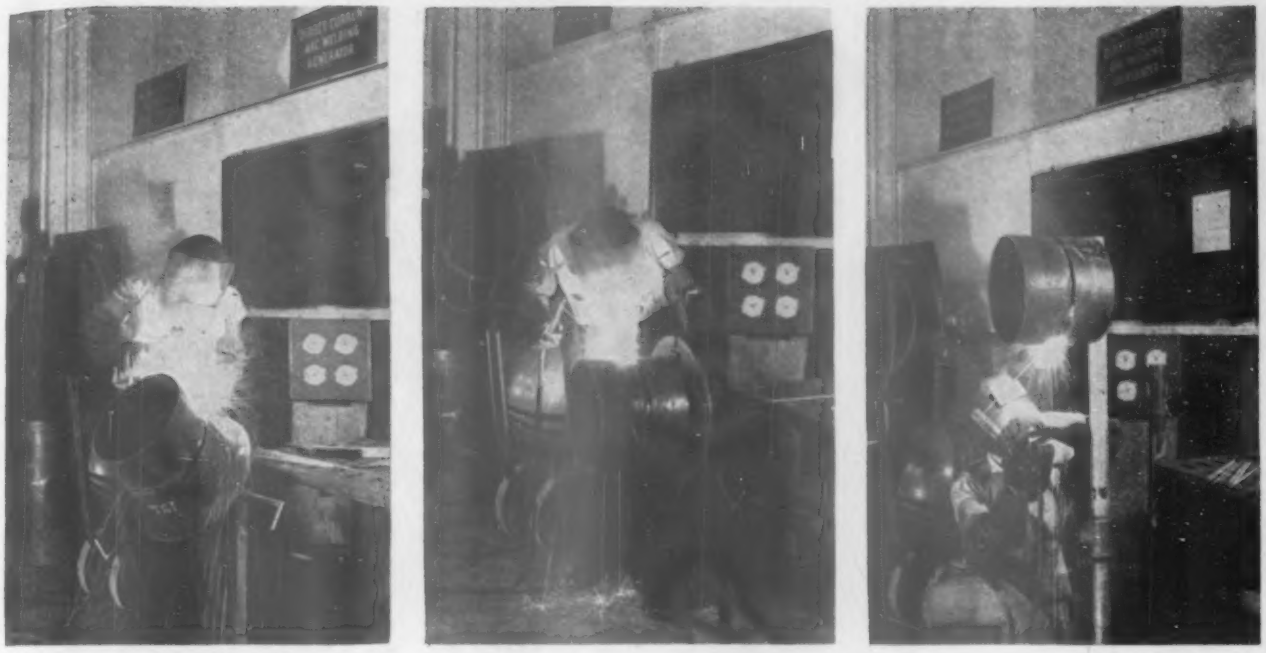


Fig. 4—These illustrations show an operator making his qualifying tests on fillet welds. Left to right: inclined horizontal rolled position (flat weld), horizontal rolled or vertical position (horizontal weld) and horizontal fixed position (vertical and overhead welds). See page 35, September, WELDING ENGINEER, for corresponding positions for butt welds

nozzle connections shown in previous articles.* Socket-type fittings may not be available in all grades of these alloys. Welds can be made in all positions.

Atomic-Hydrogen Welding

The chromium-nickel stainless steels can be welded by the atomic-hydrogen process. Like oxy-acetylene welding, the atomic-hydrogen method is most applicable to the thinner wall thicknesses of tubing because the spread of heat and longer heating time are apt to cause distortion and carbide precipitation on heavier walls. Best results are obtained with stabilized tubing in the smaller diameters and lighter gauges. Since the hydrogen atmosphere surrounding the arc reduces the chromium oxides, no flux is required. Another advantage over oxy-acetylene welding is that carbon pick-up in the deposited

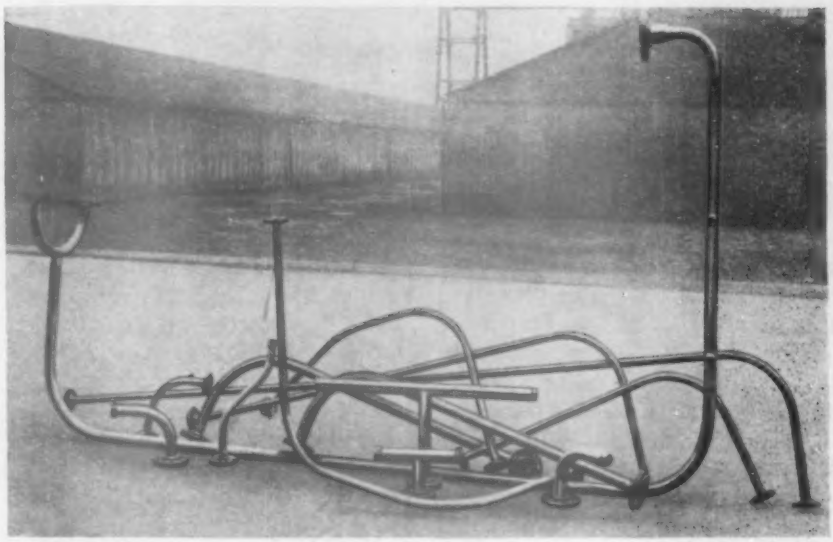


Fig. 3—Austenitic stainless piping fabricated by bending and welding

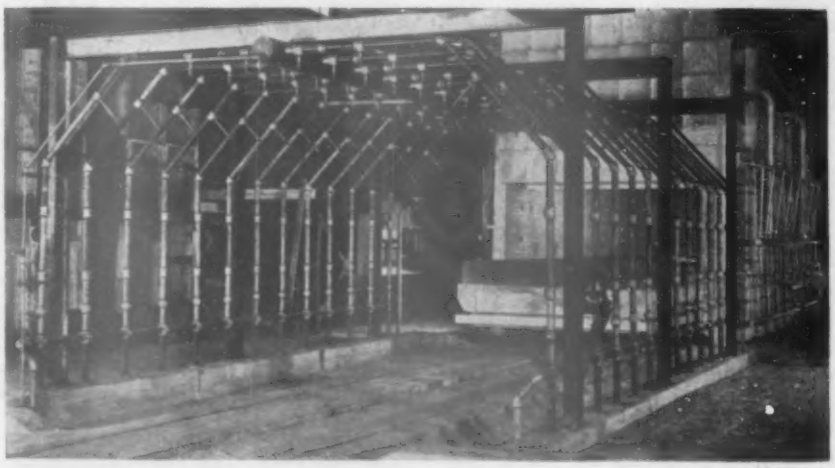


Fig. 5—Heat treatment of austenitic stainless steels is best performed in a furnace similar to this. Note the water spray for quick quenching

* Fig. 3, page 33, September, and Fig. 5, page 47, October, WELDING ENGINEER

metal is not encountered, and special rods are not required. Single-vee butt joints, fillet or socket joints and nozzle connections as shown in previous articles are recommended. Welding should preferably be in the downhand or roll position.

Metal-Arc Welding

Metal-arc welding is generally the preferred method of joining chromium-nickel stainless steels since most of the important factors are better controlled by this process. Fig. 3 shows some typical piping fabricated by arc welding. The highly localized welding heat produced by the arc narrows the heat-affected zones in the parent metals, and the time-at-temperature is reduced, thus minimizing distortion and carbide precipitation. Electrode coatings protect the arc stream of molten metal from gases in the atmosphere and often serve as a means of introducing alloying elements or compensating for their losses in the arc. A wide choice of both a-c and d-c welding electrodes is available with coatings which give weld-metal analyses matching those of the parent materials. The electrode coatings usually contain fluxing agents to dissolve the refractory chromium oxides. Control of the carbon content in the weld deposits is obtained by the use of low-carbon core wire and the avoidance of carbonaceous materials in the coatings.

Generally, no difficulty is encountered in making excellent arc welds. If correct arc length and heat setting are observed, the weld metal flows smoothly, giving deposits that are almost free of ripples. A short arc should be held in order to prevent the oxygen in the surrounding atmosphere from breaking through the gaseous envelope produced by the burning electrode coating. A long arc results in oxidation of some of the chromium, thus reducing the chromium content, and consequently the corrosion resistance, of the deposited metal. The proper arc length is one which does not smother the arc and yet is not so long that it will cause undue oxidation of the chromium.

The proper arc length cannot be maintained unless the welding current is correctly adjusted. The optimum welding heat is slightly less than would be used for the same work in mild steel. Owing to the high electrical resistance of stainless steels, a high current causes the core wire to become red hot, and the arc becomes difficult to handle. The general rule is to keep the current as low as possible—just above the point where choking or sticking of the electrode occurs.

Carbide precipitation will occur with arc welds in some of the stainless alloys. If heat treatments cannot be accomplished it is best to use stabilized alloys.

The types of welding grooves recommended for arc welding are the single vee butt joints with or without backing rings, fillet or socket joints and nozzle connections as illustrated in previous articles. Welds can generally be made in all positions, as shown by Fig. 4. Electrode sizes are generally smaller than those employed for plain-carbon steels, seldom exceeding $\frac{3}{16}$ in. diameter.

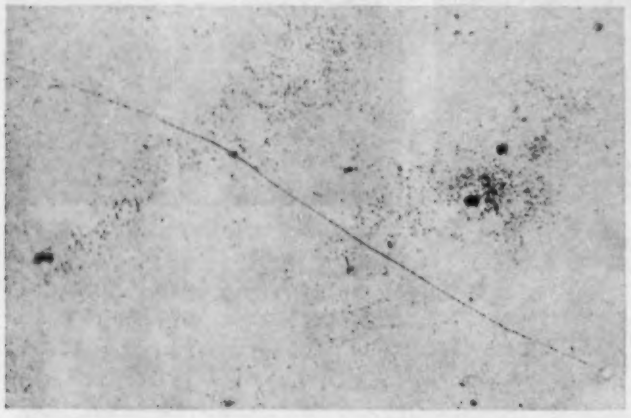


Fig. 6—Photomicrograph at 400 X of austenitic stainless steel stabilized by heating to 1,575 F for 24 hours. Note the dispersion of carbides

Preheating, Heat Treatments

Preheating, as a rule, is not employed when welding the chromium-nickel steels since these alloys are generally very ductile and non-air-hardening. To prevent carbide precipitation, it is advisable to minimize heating during welding, and preheating tends to increase the time-at-temperature.

When maximum corrosion resistance is required in unstabilized chromium-nickel steel piping, the prescribed postweld heat treatment is to heat the assemblies in a furnace to about 1,950 F for sufficient time to allow the carbides to go back into solution. This should be followed by rapid cooling to keep the carbon in solution. On relatively light gauges, cooling by an air blast is sometimes sufficient, but on heavier walls a water spray or quenching is necessary in order to effect quick cooling through the carbide precipitation range of 1,600–800 F. Note the water spray arrangement in Fig. 5.

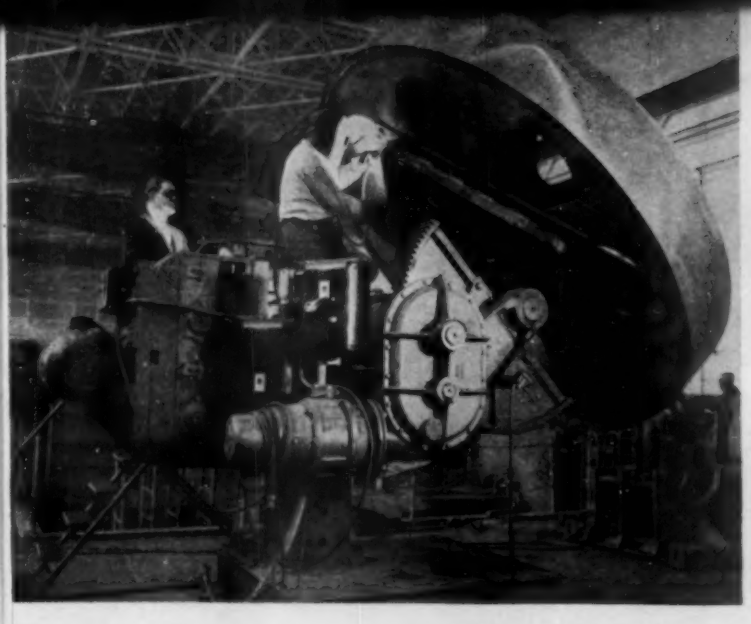
Another method of heat treatment is being given some consideration lately, particularly when stainless alloys are to be employed in high-temperature service. This is an agglomerizing or stabilizing treatment consisting of a long-time soaking of the welded assemblies in a furnace at 1,550–1,600 F, followed by air cooling. It was mentioned previously that when chromium-nickel steels are exposed to temperatures ranging from 800–1,600 F the carbides precipitate along the grain boundaries. In the stabilizing treatment, the heating time is quite prolonged in comparison to the heat exposure during welding or the quenching treatment previously described.

This stabilizing treatment allows the carbides to precipitate and disperse within the grains, thus placing the alloys in better condition to resist corrosion at elevated temperatures. The effect of stabilizing austenitic stainless steel by heating it for 24 hours at 1,575 F is shown in Fig. 6.

Columbium or titanium stabilized chromium-nickel alloys to be used at elevated temperatures are also placed in better condition by the stabilizing treatment.

WELDABLE *Alloy* MATERIALS

Materials are scarce! So that you, the fabricator of welded products, may be able to substitute alloys having similar chemical, mechanical and welding properties for materials you are unable to obtain, this extensive survey has been made. Make the available materials go as far as possible by using substitutes.



High-speed turbine gears are light and strong when alloy steels and welding are combined to produce them

Courtesy Westinghouse Electric Corp

Weldable

WARTIME know-how has taught manufacturers that their peacetime equipment should be of welded construction. The demand for increased welding has naturally brought about a need for more knowledge of the weldability of materials which go into peacetime production. Present material shortages have made it necessary in some instances to substitute materials. As a result, increased knowledge is required of the substitutes.

Can the substitute alloy be welded? Who makes it? What are its nominal chemical properties, mechanical properties? In what shapes may it be obtained? So that the reader of THE WELDING ENGINEER may have all of this information at his fingertips, the editors have compiled and published the facts on the weldability characteristics of some 343 ferrous and non-ferrous alloys.

SHEETS AND PLATES FIRST

In making this survey, questionnaires were sent to every known producer of alloy materials in the United States. So that the final results would be of greatest value to those in the welding field, only those alloy producers making sheets and plates were considered eligible for listing. These limitations naturally prevented the listing of many alloys, but it is felt that those in the welding industry are primarily interested in the welding of alloy sheets and plates. Of course, if the manufacturer who produces alloys in sheets and plates also produces them in other forms, practically all of the available forms have been listed.

The chemical compositions of the various alloys listed in the tables beginning on page 63 must not be considered to be exact. They are the nominal or approximate percentages and may vary within practical limits which will not affect materially the other qualities of the alloy. It should be noted that in many alloys, particularly those in the ferrous group, phosphorus and sulphur are not necessarily considered as impurities. These two elements are frequently added to an alloy to improve its machining qualities, which accounts for their presence in seemingly high percentages in some alloys such as the free-machining steels.

It should also be noted that many of the various types of stainless steels are produced by most of the major steel producing companies. The same is true of many of the brasses and bronzes, which are virtually the same for the three leading producers of copper alloys. The aluminum alloy materials likewise are similar in many of their characteristics, though they may be the products of various producers.

PROPERTIES OF CLAD ALLOYS

The various clad alloy materials have also been included in this survey. The stainless clads are listed among the weldable ferrous alloys. On the other hand, nickel and related clads will be found in the non-ferrous listings. In either case the chemical composition, mechanical and welding properties given refer only to the clad material, inasmuch as practically all of these clads are bonded to easy-to-weld mild-steel plate. Naturally, those references made to the welding properties are those of the clad alloys.

For all alloys, the mechanical properties of yield strength, tensile strength and ductility are also the nominal figures. In some instances they may be considered as averages, but generally it may be assumed that the figures given are the minimum expected results. The mechanical properties frequently range within wide limits because of the effects of various processing operations such as heat treating, hot and cold working, annealing, etc.

WELDABILITY CHARACTERISTICS

Unless otherwise noted in the tabulations, arc welding refers only to metal-arc welding. However, a material that is readily welded with the metal arc will generally possess equal qualities when welded by other arc processes such as atomic-hydrogen, carbon-arc, inert-gas-shielded-arc or submerged-melt welding. For if the alloy that is to be welded by one of these processes is not readily weldable with the metal arc, information regarding the results when welding by another arc process is very limited. Because of this paucity of data, arc processes other than the metal arc were not considered in this survey.

In many cases, the alloy material is weldable only if certain conditions are met. Most of these are summarized briefly in the footnotes. If further doubt exists after having noted the requirements outlined in the footnotes, we recommend that the producer of the material be consulted.

Of the ferrous alloy materials, the low-alloy, high-tensile steels and the higher alloy steels are generally judged as to their weld-

Alloy Materials

Information on the welding qualities and chemical and mechanical properties of 343 ferrous and non-ferrous materials is given on these pages.

ability from the metallurgical changes resulting because of welding. Carbon is the most important element from the standpoint of weldability. This is because carbon is a hardener, and in percentages above 0.35% produces a noticeable effect on weldability. The presence of other alloy elements—chromium, nickel, molybdenum, etc.—tends to intensify the hardening effects of carbon. As far as welding is concerned, it is desirable to keep the carbon content as low as possible. The lower the carbon, the better the welding characteristics generally.

Steels austenitic in character, *i.e.*, those which possess great ductility and toughness, are generally considered to be readily weldable since they are not particularly subject to changes because of carbon constituents and their toughness permits them to withstand welding stresses without fracture. On the other hand, martensitic steels, which are hard and brittle, are generally difficult to weld because their hardness does not permit deformation under welding stresses without fracture. These steels can be welded only if they are preheated to prevent fracture and annealed immediately after welding in order to transform the hard martensitic material into a more ductile state.

In general, the ability of a stainless steel to resist corrosion is proportionate to the amount of chromium contained in the alloy mixture. It has been found that steels with high chromium contents (25 to 30%) are much more able to resist corrosion than those with a lower percentage of chromium (10 to 14%). There are other considerations, however, that modify this general rule. When elements other than chromium are added, certain desirable properties are obtained. In some instances the additions tend to increase the ability of the alloy to resist corrosion; in other instances they add nothing so far as this property is concerned or may even reduce the corrosion-resisting qualities.

The elements that are added to stainless steels include nickel, columbium, titanium, aluminum, magnesium, tungsten, silicon and carbon. Each of these elements, when added to the chromium-iron mixture, produces an effect of some particular kind. Weldability is generally imparted by the addition of columbium or titanium. Stainless steels with such alloys are generally referred to as stabilized stainless steels. When a stabilized base metal is welded with a stabilized electrode, the weld deposit will have the same analysis as the base metal, and carbides will not be developed in the zone adjacent to the weld deposit. The lower the carbon content, the less likelihood there is of harmful carbide precipitation.

Hydrogen, Helium Processes

Atomic-hydrogen and inert-gas-shielded-arc welding methods are frequently employed in the welding of stainless steels. With these processes it is possible to weld thicknesses of less than 0.010 in. Any type of joint commonly used for the welding of ferrous materials may be employed. On the extremely light-gauge materials it is possible to flange the joint so that no filler metal is required, but for the heavier gauges a welding rod is used. When these processes are employed to weld stainless steel, it is extremely desirable to use a tungsten electrode (or electrodes) to avoid the possibility of carbon pick-up. This possibility is ever present when a carbon electrode is used, and for this reason carbon-arc welding is not recommended for stainless steel. Recent developments, however, have led to the extensive use of submerged-melt

Courtesy Aluminum Goods Manufacturing Co.

Left: Welding flux plays an important role in the successful joining of aluminum by an oxy-hydrogen flame

Right: Stainless steel is rated as an ideal material for spot welding because of its high electrical resistivity

Courtesy Bell Aircraft Co.

welding in the manufacture of stainless-steel products.

Stainless steel has always been an ideal material for resistance-welding applications because of its high electrical resistivity. Short timing of the welding current is essential for the elimination of precipitated carbides in the steels that are not stabilized.

Cleaning is particularly important with stainless sheets and plates, which are frequently received from the mill with scale, grease and other foreign materials present.

Classifying Copper Alloys

Copper is one of the most versatile of metals because of its readiness to combine with other elements to make alloys. There are many copper alloys used in commercial applications, and it is necessary to classify them into general groups according to: (1) similarity in the character of the elements added to copper and (2) similarity in the reactions of the alloys to ferrous welding.

Some of the elements used in the making of copper alloys vary in wide proportions and cover a wide range of properties. For example, the proportion of zinc used in the making of 15 or so commercial brasses may vary from 1 to 50%.

Copper alloys are also modified in their properties by the use of more than one alloying element. In some instances, as many as five elements are used in varying proportions. Such additions greatly extend the general range of properties and the general usefulness of copper-based alloys.

As a general rule, most copper alloys may be welded by arc and gas welding methods, for their melting points are readily within the range of these welding processes. The melting points of the various elements which go to make up the copper alloys offer no difficulty so far as welding operations are concerned. However, the boiling points of three elements—cadmium, phosphorus and zinc—impose limitations on the alloys that contain them.

Alloys which approach pure copper are, of course, difficult to resistance weld because of their high conductivities.

As is indicated by the various footnotes, the carbon arc is used extensively in the welding of the copper alloys. Preheat also plays an important part in the welding of many of these materials. In oxy-acetylene welding, a slight oxidizing flame is frequently recommended, and a flux is necessary. Extreme care must be exercised with materials that are hot short in order to prevent weld cracking in rigidly contained structures.

Magnesium and Aluminum

In the light metal field, we find that magnesium and aluminum alloys are striving to serve the same purposes. The manner in which they are welded is quite similar. Both are readily weldable so far as most of their alloys are concerned. After magnesium alloys have been welded, however, extreme care must be exercised to insure the complete removal of all flux, or corrosion will develop. For this reason, the newly developed inert-gas-shielded-arc process which does not require a flux is coming into its own. Because a flux is not employed with this method, undue care in joint design does not have to be exercised, and all types of joints commonly used for steel may also be used for magnesium or aluminum alloys. This is impossible when using either arc or gas welding methods because of the danger of entrapping flux in many joint designs.

Courtesy American Welding & Mfg. Co.

The weldability of materials is amply demonstrated in this butt-welded ring. Strength is not sacrificed in any of the weld areas which join SAE 1020, 1040 and 1060 steel, SAE 52100 and NE 8745 alloys, 1808Cb stainless, Monel and Armco metal into one structure

Because of the intensity of the inert-gas-shielded arc, complete penetration can be secured on sheets up to 3/16 in. thick, even when they are only butted together. Heavier materials are usually prepared with a single 90-deg included vee. Thicker materials (1/2 in. and over) should be beveled with a double vee prior to welding.

Most of the magnesium alloys may be readily spot welded under conditions similar to those encountered in the welding of aluminum.

Heat Treatable and Not

The wrought-aluminum alloys may be divided into two major groups: non-heat-treatable and heat-treatable alloys. The non-heat-treatable alloys can be strengthened only by cold working, which means that when they are welded they lose much of their strength unless they can again be cold worked. Even though such alloys are reworked after welding, it is difficult to bring them up to their original strength.

The heat-treatable alloys require suitable thermal treatment to develop their optimum properties. As a rule, they may be heat-treated or reheat-treated after welding so that the higher physical properties brought about by heat treatment may be developed or retained.

Cleanliness is one of the most important factors in the welding of aluminum alloys, whether it be by gas, arc or resistance welding. In resistance welding, in particular, it should be noted that it is next to impossible to weld dirty material. There are many ways by which aluminum may be cleansed. The first step, however, is always that of degreasing. Any oil or grease dissolving operation combined with some mechanical action such as spraying or wiping is satisfactory if it results in the positive removal of all grease and oil. Following degreasing, there must be some surface cleaning method employed to remove the oxide film and bring out the bright metal below.

WELDABLE ALLOY MATERIALS—FERROUS

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
1	AISI 4608	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .040 max; C .06-.11; Mn .40; Si .25 max; Ni 1.40-1.75; Mo .15-.25	t	t	t	S, CR	A	D	A	1
2	AISI A-2330	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .040 max; C .28-.33; Mn .60-.80; Si .20-.35; Ni 3.25-3.75	u	u	u	S, P, B	B[1]	D	D	2
3	AISI A-4142	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .040 max; C .40-.45; Mn .75-1.00; Si .20-.35; Cr .80-1.10; Mo .15-.25	u	u	u	P, B	B[3]	D	B[3]	3
4	AISI E-4337	U.S. Steel Corp., Pittsburgh, Pa.	S .025 max; P .025 max; C .35-.40; Mn .60-.80; Si .20-.35; Ni 1.65-2.00; Cr .70-.90; Mo .23-.30	u	u	u	P	B[3]	D	D	4
5	ASTM A-203 Grade A(a)	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .035 max; C .17 max; Mn .80 max; Si .15-.30; Ni 2.00-2.75	55% T.S.	65-77	v	P	B[1]	D	D	5
6	ASTM A-203 Grade B(a)	U.S. Steel Corp., Pittsburgh, Pa.‡	S .040 max; P .035 max; C .20 max; Mn .80 max; Si .15-.30; Ni 2.00-2.75	55% T.S.	70-82	v	P	B[1]	D	D	6
7	ASTM A-203 Grade C(a)	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .035 max; C .25 max; Mn .80 max; Si .15-.30; Ni 2.00-2.75	55% T.S.	75-87	v	P	B[1]	D	D	7
8	ASTM A-204 Grade A(b)	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .035 max; C .18-.25 max; Mn .50-.90; Si .15-.30; Mo .40-.60	55% T.S.	65-77	w	P, B	B[3]	D	D	8
9	ASTM A-204 Grade B(b)	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .035 max; C .20-.27 max; Mn .50-.90; Si .15-.30; Mo .40-.60	55% T.S.	70-82	w	P, B	B[3]	D	D	9
10	ASTM A-204 Grade C(b)	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .035 max; C .23-.28 max; Mn .50-.90; Si .15-.30; Mo .40-.60	55% T.S.	75-87	w	P, B	B[3]	D	D	10
11	ASTM A-225-39 Grade A(c)	U.S. Steel Corp., Pittsburgh, Pa.‡	S .040 max; P .035 max; C .18 max; Mn 1.45 max; Si .15-.30; V .08-.14	55% T.S.	70-82	w	P	A	D	D	11
12	ASTM A-225-39 Grade B(c)	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .035 max; C .20 max; Mn 1.45 max; Si .15-.30; V .08-.14	55% T.S.	75-87	w	P	A	D	D	12

*Yield strength is that load which will produce an elongation of .002" in 1". The value is obtained from stress-strain curves, and is based on a 29,000,000 psi Modulus of Elasticity for steel, 6,500,000 psi for magnesium alloys, 10,300,000 psi for aluminum, 15,000,000 psi for brasses, 20,000,000 psi for 70/30 cupro-nickel.

**Single figure (50) indicates minimum value. Double figures (28-50) indicate range, which varies because of production processes or other causes; e.g., heat treatment, annealing, cold rolling, drawing, etc.

†Available forms: P=plates, S=sheets, CR=cold rolled, HR=hot rolled, B=bars, W=wire, T=tubing or pipe, R=rods.

‡‡Welding Qualities: A=Readily weldable. B=Weldable under favorable conditions (see footnotes). C=Not ordinarily weldable. D=No welding data available.

‡Also available from Alan Wood Steel Co., Conshohocken, Pa.

a. Nickel Steel to A.S.T.M. Specs., b. Carbon Moly to A.S.T.M. Specs., c. Manganese Vanadium to A.S.T.M. Specs.

t. Used as furnished. u. Usually heat treated. v. 1,650,000/T.S. w. 1,750,000/T.S.

1. The necessity for stress relief annealing usually depends on the character of part and service. Adequate preheat can confer practically the same metallurgical advantage as post heating. 2. Can be flash welded. 3. Preheat during welding is required; the temperature during welding should be suitable for the composition and thickness of the material. Special welding technique required also.

WELDABLE ALLOY MATERIALS—FERROUS

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
14	Abrasion Resisting	Lukens Steel Co. Coatesville, Pa.‡	S .034; P .030; C .43; Mn 1.80; Si .27	75	120	21	S, P	B[3]	B[3]	D	14
15	Allegheny Metal 17-7	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .09-.20; Mn 2.00 max; Ni 6-8 Cr 16-18	25	80	55	Strip	A	X	A	15
16	Allegheny Metal 18-8	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .09-.20; Mn 1.25 max; Ni 8-10; Cr 17-19	25	80	55	S, P, CR, B, W, T, C, Strip	A	X	A	16
17	Allegheny Metal 18-8-S	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .08 max; Mn 2.0 max; Ni 8-10; Cr 18-20	25	80	55	S, P, CR, HR, B, W, T, C, Strip	A	X	A	17
18	Allegheny Metal 20-10-S	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .08 max; Mn. 2.0 max; Ni 10-12; Cr 19-21	25	80	55	S, P, CR, HR, B, W, T, C, Strip	A	X	A	18
19	Allegheny Metal 25-12	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .20 max; Ni 12-14; Cr 22-26	30	75	40	S, P, CR, B, W, C, Strip	A	X	A	19
20	Allegheny Metal 25-12-S	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .08 max; Ni 12-15; Cr 22-24	30	75	40	S, P, CR, B, W, C, Strip	A	X	A	20
21	Allegheny Metal 25-20	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .25 max; Ni 19-22; Cr 24-26	30	70	40	S, P, CR, B, W, T, C, Strip	A	X	A	21
22	Allegheny Metal 18-8-M	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .10 max; Ni 10-14; Cr 16-18; Mo 2-3	30	75	40	S, P, CR, B, W, T, C, Strip	A	X	A	22
23	Allegheny Metal 18-8-M Spec.	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .10 max; Ni 10-14; Cr 17.5-20; Mo 3-4	30	75	40	S, P, CR, B, W, T, C, Strip	A	X	A	23
24	Allegheny Metal 18-8-T	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .10 max; Ni 8-11; Cr 17-19; Ti 4xC Min	25	75	40	S, P, CR, B, W, T, C, Strip	A	X	A	24
25	Allegheny Metal 18-8-C	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .10 max; Ni 9-12; Cr 17-19; Cb 8 x C min	30	80	40	S, P, CR, B, W, T, C, Strip	A	X	A	25
26	Allegheny Metal 12-NH	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .08 max; Cr 11.5-13.5; Al .10-.30	35	60	20	S, P, CR, B, W, T, Strip	A	X	B[4]	26
27	Allegheny Metal 12	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	S .025 max; P .025 max; C .15 max; Mn .50 max; Si .75 max; Cr 11.5-13.5	32	60	20	S, P, CR, B, W, T, Strip	A	X	B[4]	27
28	Allegheny Metal 17	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	S .025 max; P .025 max; C .12 max; Mn .50 max; Si .75 max; Cr 16-18	35	60	20	S, P, CR, B, W, T, Strip	A	X	B[4]	28
29	Allegheny Metal 21	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .25 max; Cr 18-23	35	60	20	S, P, B, W, Strip	A	X	B[4]	29
30	Allegheny Metal 28	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .35 max; Cr 23-30	45	75	20	S, P, CR, B, W, T, Strip	A	X	B[4]	30
31	Allegheny Metal 46 Type 501	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C over .10; Cr 4-6	25	60	30	S, P, B, W, Strip, Billets, and Forgings	A	X	B[4]	31
32	Allegheny Metal 46 Type 502	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	C .10 max; Cr 4-6	25	60	30	S, P, B, W, T, Strip, Billets, and Forgings	A	X	B[4]	32
33	Allegheny Pluramelt	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	Carbon steel bonded integrally on one or both sides with many of the above stainless steels				S, P, Strip	A	C	B[3]	33

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
34	Armco Aluminized Steel	American Rolling Mill Co., Middletown, Ohio	S .03; P .008; C .070; Mn .360; Si .003	30	45	15	S, P	B	B	B[8]	34
35	Armco and Rustless Stainless Steel 17-7	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C over .08-.15; Mn 2.00 max; Si 1.00 max; Ni 6-8; Cr 16-18	40-240	105-270	60-65	S, P, B, W	A	A	A	35
36	Armco and Rustless Stainless Steel 18-8 Type 302	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C over .08-.15; Mn 2.00 max; Si 1.00 max; Ni 8-10; Cr 17-19	35-225	90-250	60-65	S, P, B, W	A	A	A	36
37	Armco and Rustless Stainless Steel 18-8 Type 304	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C .08 max; Mn 2.00 max; Si 1.00 max; Ni 8-11; Cr 18-20	30-225	85-250	60-65	S, P, B, W	A	A	A	37
38	Armco and Rustless Stainless Steel 25-12	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C .20 max; Mn 2.00 max; Si 1.00 max; Ni 12-15; Cr 22-24	35-165	90-190	50-55	S, P, B, W	A	A	A	38
39	Armco and Rustless Stainless Steel 18-12 Mo	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C .10 max; Mn 2.00 max; Si 1.00 max; Ni 10-14; Cr 16-18; Mo 1.75-2.75	30-180	85-205	60-65	S, P, B, W	A	A	A	39
40	Armco and Rustless Stainless Steel 18-10 Cb	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C .10 max; Mn 2.00 max; Si 1.00 max; Ni 9-12; Cr 17-19; Cb min 10 x C	35-175	90-190	50-55	S, P, B, W	A	A	A	40
41	Armco and Rustless Stainless Steel 27	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C .35 max; Mn 1.00 max; Si 1.00 max; Cr 23-27; Ni .25 max	50-100	80-135	25-10	S, P, B, W	B[4]	B[7]	B[4]	41
42	Armco and Rustless Stainless Steel 17	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C .12 max; Mn 1.00 max; Si 1.00 max; Cr 14-18	40-100	75-110	35-38	S, P, B, W	B[4]	B[7]	B[4]	42
43	Armco and Rustless Stainless Steel 20-10	American Rolling Mill Co., Middletown, Ohio	S .03 Max; P .04 Max; C .08 max; Mn 2.00 max; Si 1.00 max; Cr 19-21; Ni 10-12	30-175	85-200	55-5	S, P, B, W	A	A	A	43
44	Armco and Rustless Stainless Steel 18-10.7	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C .10 max; Mn 2.00 max; Si 1.00 max; Cr 17-19; Ni 8-11; Ti 5 x C min	30-175	85-190	55-5	S, P, B, W	A	A	A	44

*Yield strength is that load which will produce an elongation of .002″ in 1″. The value is obtained from stress-strain curves, and is based on a 29,000,000 psi Modulus of Elasticity for steel, 6,500,000 psi for magnesium alloys, 10,300,000 psi for aluminum, 15,000,000 psi for brasses, 20,000,000 psi for 70/30 cupro-nickel.

**Single figure (50) indicates minimum value. Double figures (28-50) indicate range, which varies because of production processes or other causes; e.g., heat treatment, annealing, cold rolling, drawing, etc.

†Available forms: P=plates, S=sheets, CR=cold rolled, HR=hot rolled, B=bars, W=wire, T=tubing, or pipe, R=rods.

‡‡Welding Qualities: A=Readily weldable. B=Weldable under favorable conditions (see footnotes). C=Not ordinarily weldable. D=No welding data available. X=This method of gas welding may be applied successfully to the chromium nickel and straight chromium alloys under certain conditions, but it is not as well adapted for general work with these alloys as is the metallic arc method. It is frequently employed on 20 gauge and lighter material.

‡Also available from Alan Wood Steel Co., Conshohocken, Pa.

3. Preheat during welding is required; the temperature during welding should be suitable for the composition and thickness of the material. Special welding technique required also. 4. Annealing suggested to remove brittleness and to improve ductility. 5. Thin sections. 6. Postheat. 7. Unable to make ductile. 8. Requires about 20% more current than mild steel.

WELDABLE ALLOY MATERIALS—FERROUS

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
45	Armco and Rustless Stainless Steel 12-T	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C .15 max; Mn 1.00 max; Si 0.50 max; C 11.5-13.0	35-145	65-190	30-5	B	B[4]	B[4]	B[4]	45
46	Armco and Rustless Stainless Steel 12	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C .15 max; Mn 1.00 max; Si 1.00 max; Cr 11.5-13.5	35-145	65-190	30-5	B, W	B[4]	B[4]	B[4]	46
47	Armco and Rustless Stainless Steel 12-2	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C .15 max; Mn 1.00 max; Si 1.00 max; Cr 11.5-13.0; Ni 1.25-2.50	80-150	100-200	23-15	B, W	B[4]	B[7]	B[4]	47
48	Armco and Rustless Stainless Steel 16-2	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C .20 max, Mn 1.00 max; Si 1.00 max; Cr 15-17; Ni 1.25-2.50	95-155	120-180	20-5	B, W	B[4]	B[4]	B[4]	48
49	Armco and Rustless Stainless Steel 25-20	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C .25 max; Mn 2.00 max; Si 1.5 max; Cr .24-.26; Ni 19-22	40-180	95-200	45-20	B, W	A	A	A	49
50	Armco Cold-Rolled Paintgrip	American Rolling Mill Co., Middletown, Ohio	S .03; P .008; C .070; Mn .360; Si .003	30	45	15	S, P, CR	A	A	A	50
51	Armco Galv. Ingot Iron	American Rolling Mill Co., Middletown, Ohio	S .025; P .005; C .015; Mn .035; Si .003	30	45	35	S, P	A	A	A	51
52	Armco Galvanized C-B Steel	American Rolling Mill Co., Middletown, Ohio	S .030; P .008; C .070; Mn .360; Si .003; Cu .20 min	30	45	29	S, P	A	A	A	52
58	Armco Galvanized O-H Steel	American Rolling Mill Co., Middletown, Ohio	S .030; P .008; C .070; Mn .360; Si .003	30	45	32	S, P	A	A	A	53
54	Armco Galvanized Paintgrip Ingot Iron	American Rolling Mill Co., Middletown, Ohio	S .025; P .005; C .015; Mn .035; Si .003	30	45	35	S, P	A	A	B[11]	54
55	Armco Galvanized Paintgrip Copper-Bearing Steel	American Rolling Mill Co., Middletown, Ohio	S .030; P .008; C .070; Mn .360; Si .003; Cu .20 min	30	45	29	S, P	A	A	B[11]	55
56	Armco Galvanized Paintgrip O. H. Steel	American Rolling Mill Co., Middletown, Ohio	S .030; P .008; C .070; Mn .360; Si .003	30	45	32	S, P	A	A	B[11]	56
57	Armco Hot and Cold Rolled	American Rolling Mill Co., Middletown, Ohio	P .008-.025; C .04-.08; Mn .20-.50; Cu as specified	28-85	45-85	40-4	S, P	A	A	A	57
58	Armco Ingot Iron	American Rolling Mill Co., Middletown, Ohio	S .025; P .005; C .015; Mn .035; Si .003	30	45	35	S, P	A	A	A	58
59	Armco Long Terne Sheets	American Rolling Mill Co., Middletown, Ohio		26-57	30-45	26-44	S, P	A	A	A	59
60	Armco Stainless Steel 13	American Rolling Mill Co., Middletown, Ohio	S .03 max; P .04 max; C .15 max; Mn 1.00 max; Si 1.00 max; Cr 11.5-13.5	145	190	35	S, P	B[4]	B[4]	B[4]	60
61	Armco Zincgrip Ingot Iron	American Rolling Mill Co., Middletown, Ohio	S .025; P .005; C .015; Mn .035; Si .003	40	55	28	S, P	A	A	A	61
62	Armco Zincgrip Copper-Bearing Steel	American Rolling Mill Co., Middletown, Ohio	S .030; P .008; C .070; Mn .360; Si .03; Cu .20 min.	45	60	28	S, P	A	A	A	62

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
63	Armco Zincgrip O. H. Steel	American Rolling Mill Co., Middletown, Ohio	S .030; P .008; C. 070; Mn .360; Si .003	45	60	30	S, P	A	A	A	63
64	Armco Zincgrip-Paintgrip Ingot Iron	American Rolling Mill Co., Middletown, Ohio	S .025; P .005; C .015; Mn .035; Si .003	40	55	28	S, P	A	A	B	64
65	Armco Zincgrip-Paintgrip Cu. Bear. Steel	American Rolling Mill Co., Middletown, Ohio	S .030; P .008; C .070; Mn .360; Si .003; Cu .20 min	45	60	28	S, P	A	A	B	65
66	Armco Zincgrip-Paintgrip O. H. Steel	American Rolling Mill Co., Middletown, Ohio	S .030; P .008; C .070; Mn .360; Si .003	45	60	30	S, P	A	A	B	66
67	A. W. Dynalloy	Alan Wood Steel Co., Conshohocken, Pa.	C .12; Mn .75; P .080; Cu .40; Ni .60; Mo .80	50	70	28	S, P	A	A	A	67
68	"Band Hack"	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C 1.25-1.32; Mn .10-.25; Si .10-.20; Cr .10-.20	124.1	151.1	9.5	S, P, CR, HR, B	B[8]	B[8]	B[8]	68
69	"Best Tool"	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .80-1.; Mn .20-.40; Si .15-.30; Ni .10 max; Cr .10 max	174	193.6	7	S, P, CR, B	A	A	A	69
70	Carbon Molybdenum A-204-A	Lukens Steel Co., Coatesville, Pa.	S .019; P .019; C .15; Mn .80; Si .22; Mo .46	42	68	35	P	A	A	A	70
71	Carbon Molybdenum A-204-B	Lukens Steel Co., Coatesville, Pa.	S .021; P .018; C .18; Mn .83; Si .20; Mo .50	46	75	33	P	B[9]	B[9]	B[9]	71
72	Carbon Molybdenum A-204-C	Lukens Steel Co., Coatesville, Pa.	S .025; P .16; C .20; Mn .80; Si .19; Mo .52	54	81	28	P	B[10]	B[10]	B[10]	72
73	Carbon Moly (under ¾ gauge)	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .040 max; C .18 max; Mn .80-1.10; Si .15-.25; Mo .40-.60	43.5	72	x	P	B[3]	D	D	73
74	Carbon Moly (over ¾ gauge)	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .040 max; C .20 max; Mn .80-1.10; Si .15-.25; Mo .40-.60	40	70	x	P	B[3]	D	D	74
75	Carbon Moly High Manganese	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .035 max; C .25 max; Mn 1.15-1.50; Si .25 max; Mo .40-.60	65	80-105	y	P	B[3 9]	D	D	75
76	Carbon Nickel	Lukens Steel Co., Coatesville, Pa.	S .018; P .014; C .24; Mn .62; Si .22; Ni 3.52	54	94	22	P	B[10]	B[10]	B[10]	76

*Yield strength is that load which will produce an elongation of .002″ in 1″. The value is obtained from stress-strain curves, and is based on a 29,000,000 psi Modulus of Elasticity for steel, 6,500,000 psi for magnesium alloys, 10,300,000 psi for aluminum, 15,000,000 psi for brasses, 20,000,000 psi for 70/30 cupro-nickel.

**Single figure (50) indicates minimum value. Double figures (28-50) indicate range, which varies because of production processes or other causes; e.g., heat treatment, annealing, cold rolling, drawing, etc.

†Available forms: P=plates, S=sheets, CR=cold rolled, HR=hot rolled, B=bars, W=wire, T=tubing or pipe, R=rods.

‡‡Welding Qualities: A=Readily weldable. B=Weldable under favorable conditions (see footnotes). C=Not ordinarily weldable. D=No welding data available.

x. 1,500,000/T.S. y. 2,000,000/T.S.

›. Preheat during welding is required; the temperature during welding should be suitable for the composition and thickness of the material. Special welding technique required also. 4. Annealing suggested to remove brittleness and to improve ductility. 7. Unable to make ductile. 8. Preheat—cool slowly. 9. Low preheat 100-300 F is desired or recommended during welding. 10. Preheat during welding is required; the temperature during welding should be suitable for the composition and thickness of the material. 11. Requires more current than plain galvanized.

WELDABLE ALLOY MATERIALS—FERROUS

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
77	Carbon-Silicon A-201-A	Lukens Steel Co.,‡ Coatesville, Pa.	S .03; P .02; C .18; Mn .60; Si .20	38	62	35	S, P	A	A	A	77
78	Carbon-Silicon A-201-B	Lukens Steel Co., Coatesville, Pa.	S .035; P .017; C .22; Mn .65; Si .18	40	67	33	P	A	A	A	78
79	Carbon-Silicon A-212-A	Lukens Steel Co.,‡ Coatesville, Pa.	S .032; P .018; C .25; Mn .70; Si .21	42	72	31	S, P	A	A	A	79
80	Carbon-Silicon A-212-B	Lukens Steel Co.,‡ Coatesville, Pa.	S .031; P .020; C .28; Mn .77; Si .20	44.5	77	29	S, P	A[11]	A[11]	A[11]	80
81	Chromium-Copper-Nickel	Lukens Steel Co., Coatesville, Pa.	C .10 max; Mn .10-.60; P .040 max; S .040 max; Si .15-.30; Cr .40-.60; Ni .60-.80; Cu .40-.60	50% T.S.	65	25	P, S, HR	A[11]	A[11]	A[11]	81
82	Chromium-Manganese	Alan Wood Steel Co., Conshohocken, Pa.	S .027 max; P .023 max; C .30; Mn .98; Si .21; Cr .48	t	t	t	S, P	B[8]	B[8]	B[8]	82
83	Chromium-Manganese	Lukens Steel Co., Coatesville, Pa.	S .027; P .023; C .40; Mn .98; Si .21; Cr .48	70	110	18	P	C	C	C	83
84	Chromium-Molybdenum	Lukens Steel, Co., Coatesville, Pa.	C .15 max; Mn .30-.60; P .040 max; S .040 max; Si .15-.30; Cr .40-.60; Mo .30-.60	45	70-90	20	P, S, HR	A[11]	A[11]	A[11]	84
85	Cor-Ten	U.S. Steel Corp., Pittsburgh, Pa.	S .03 max; P .07-.20; C .12 max; Mn 1.10-1.60; Si .25-1.00; Cu 30-50 Ni .55 max; Cr .50-1.50	50	70	22	S, P, CR, HR, B, W	A	A	A	85
86	Cr-Mn-Si (CMS) A-202-A	Lukens Steel Co., Coatesville, Pa.	S .030; P .016; C .16; Mn 1.30; Si .75; Cr .50	54	85	24	P	B[10]	B[10]	B[10]	86
87	Cr-Mn-Si A-202-B	Lukens Steel Co., Coatesville, Pa.	S .032; P .019; C .22; Mn 1.27; Si .80; Cr .53	60	95	22	P	B[10]	B[10]	B[10]	87
88	Croloy	Henry Disston & Sons, Tacony, Philadelphia, Pa.	S .025; P .025; C 1.75-1.85; Mn .25-.35; Si .20-.30; Cr 12-12.50	127.2	177.8	4.5	S, P, B	C	C	C	88
89	Cumoloy	Republic Steel Corp., Massillon, Ohio.	S .04 max; P .04 max; C .25 max; Mn .70-1.25; Si .20 max; Cu .65-.85; Mo .20-.30	50	70	25	S, P, CR, B	A	D	A	89
90	Dissteel	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C 1.72-1.85; Mn .25-.35; Si .20-.30; Cr 12-12.50	127.2	177.8	4.5	S, P, B	C	C	C	90
91	Disston 841	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .40; Mn .30; Si .20; Cr .70; Mo .15-.25	123.6	183.3	10	S, P, B	A	A	A	91
92	Disston 843	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .40-.50; Mn .70-.90; Si .40-.60; Cr .70-.90	145	168.1	10	S, P, B, Strip	B[8]	B[8]	D	92
93	Disston 844	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .95-1.05; Mn .25-.35; Si .20-.30; Cr 1.00-1.25	123.5	165.4	12	S, P, B, Strip	B[8]	B[8]	D	93
94	Disston 845c	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .72; Mn .67; Si .29; Cr 1.21; V .24; Mo .71	175	186	16	S, P, B, Strip	B[8]	B[8]	D	94

No. | Material | Manufacturer | Nominal Chemical Composition (Per cent) | Yield Stgth.* | Tensile Stgth.** | Elongation % | Forms Available† | Welding Qualities‡‡ | No.

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No
								Arc	Gas	Resistance	
95	Disston 847	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .50-.60; Mn .69-.89; Si 1.24-1.49; Cr .39-.59; V .03-.15	131.2	173.1	10.5	S, P, B	B[8]	B[8]	D	95
96	Disston 864	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .75; Mn .75; Si .20; Mo .25	176.5	192	7	S, P, B	B[8]	B[8]	B[8]	96
97	Disston 865	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .75; Mn .75; Si .20; Mo .50	166.5	206	10	S, P, B	B[8]	B[8]	B[8]	97
98	Disston 870	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .70; Mn .60; Si .20; Mo .25	195.1	207	6	S, P, B	B[8]	B[8]	B[8]	98
99	Elkro	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .45-.55; Mn .50-.80; Si .20-.30; Cr .80-1.10; V .15-.25	138.4	159.2	10.5	S, P, B, Strip	B[8]	B[8]	D	99
100	Enduro S-1	Republic Steel Corp., Massillon, Ohio	S .030 max; P .030 max; C .15 max; Mn .60 max; Si .50 max; Cr 10.0-14.0	35-45	65-85	25-35	S, P, CR, B, W	B	B	B	100
101	Enduro AA	Republic Steel Corp., Massillon, Ohio	S .030 max; P .030 max; C .12 max; Mn .60 max; Si .50 max; Cr 14.0-18.0	45-55	75-90	20-30	S, P, CR, B, W	B	B	B	101
102	Enduro HC	Republic Steel Corp., Massillon, Ohio	S .030 max; P .030 max; C .35 max; Mn .60 max; Si .50 max; Cr 23.0-30.0	45-60	57-95	20-30	S, P, CR, B, W	B	B	B	102
103	Enduro 18-8	Republic Steel Corp., Massillon, Ohio	S .030 max; P .030 max; C .20 max; Mn 2.00 max; Si .75 max; Ni 8.0-10.0; Cr 17.5-20.0	35-45	80-90	55-60	S, P, CR, B, W	A	A	A	103
104	Enduro 18-8S	Republic Steel Corp., Massillon, Ohio	S .030 max; P .030 max; C .08 max; Mn 2.00; Ni 8.0-10.0; Cr 18.0-20.0 Si .75	35-45	80-90	55-60	S, P, CR, B, W	A	A	A	104
105	Enduro 18-8S Ti	Republic Steel Corp., Massillon, Ohio	S .030 max; P .030 max; C .08 max; Mn 2.00 max; Si .75 max; Ni 8.0-10.0; Cr 17.0-19.0	35-45	80-90	55-60	S, P, CR, B, W	A	A	A	105
106	Enduro 18-8 SCb	Republic Steel Corp., Massillon, Ohio	S .030 max; P .030 max; C .08 max; Mn 2.00; Si .75; Ni 8.0-12.0; Cr 17.0-19.0	35-45	80-90	55-60	S, P, CR, B, W	A	A	A	106
107	Enduro 18-8 S Mo	Republic Steel Corp., Massillon, Ohio	S .030 max; P .030 max; C .08 max; Mn 2.00; Si .75 max; Ni 9.0-14.0; Cr 16.0-18.0; Mo 2.0-3.0	35-45	80-90	55-60	S, P, CR, B, W	A	A	A	107
108	Enduro H C N	Republic Steel Corp., Massillon, Ohio	S .030 max; P .030 max; C .20 max; Mn 2.00 max; Ni 11.0-14.0; Cr 22.0-26.0; Si .75	40-60	90-110	50-65	S, P, CR, B, W	A	A	A	108

*Yield strength is that load which will produce an elongation of .002″ in 1″. The value is obtained from stress-strain curves, and is based on a 29,000,000 psi Modulus of Elasticity for steel, 6,500,000 psi for magnesium alloys, 10,300,000 psi for aluminum, 15,000,000 psi for brasses, 20,000,000 psi for 70/30 cupro-nickel.

**Single figure (50) indicates minimum value. Double figures (28-50) indicate range, which varies because of production processes or other causes; e.g., heat treatment, annealing, cold rolling, drawing, etc.

†Available forms: P=plates, S=sheets, CR=cold rolled, HR=hot rolled, B=bars, W=wire, T=tubing or pipe, R=rods.

‡‡Welding Qualities: A=Readily weldable. B=Weldable under favorable conditions (see footnotes). C=Not ordinarily weldable. D=No welding data available.

‡Also available from Alan Wood Steel Co., Conshohocken, Pa.

t. Used as furnished.

8. Preheat—cool slowly. 10. Preheat during welding is required; the temperature during welding should be suitable for the composition and thickness of the material. 11. Low preheat 100-300 F is desired or recommended during welding in heavy sections.

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
109	Enduro N C 3	Republic Steel Corp., Massillon, Ohio	S .030 max; P .030 max; C .25 max; Mn 2.00 max; Si .75; Ni 19.0-21.0; Cr 23.0-26.0	40-60	90-110	45-55	S, P, CR, B, W	A	A	A	109
110	Fast Finishing	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C 1.30-1.40; Mn .20-.30; Si .15-.25; Cr 1.00-1.20; W 2.50-3.00	131.7	142.5	16	W	C	C	D	110
111	Granite City Hi-Yield	Granite City Steel Co., Granite City, Ill.	S .035; P .080 max; C .18; Mn 1.05; Si .25; Cr .10; Cu .30	50	70	28	S, P, CR	A	A	B[12]	111
112	"Hack Saw"	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C 1.15-1.25; Mn .25-.35; Si .15-.25; Cr .10-.20; W .90-1.10	153.3	184	5.5	S	C	C	D	112
113	IngAclad Stainless Clad Steel Type 302	Ingersoll Steel & Disc, Chicago	S .030; P .030; C .08-.20; Mn 1.25; Si .50; Ni 8-10; Cr 17.5-20	40-50	60-70	50-40	S, P	A	C	B[5]	113
114	IngAclad Stainless Clad Steel Type 304	Ingersoll Steel & Disc, Chicago	S .030; P .030; C .08 max; Mn .60; Si .50; Ni 8-10; Cr 18-20	40-50	60-70	50-40	S, P	A	C	B[5]	114
115	IngAclad Stainless Clad Steel Type 316	Ingersoll Steel & Disc, Chicago	S .030; P .030; C .10 max; Mn .60; Si .50; Ni 10-14; Cr 16-18; Mo 2-3	40-50	60-70	50-40	S, P	A	C	B[5]	115
116	IngAclad Stainless Clad Steel Type 347	Ingersoll Steel & Disc, Chicago	S .030; P .030; C .10 max; Mn .60; Si .50; Ni 8-12; Cr 17-20; Cb 10 x C	40-50	60-70	50-40	S, P	A	C	B[5]	116
117	Ingersoll Stainless Steel Type 302	Ingersoll Steel & Disc, Chicago	S .030; P .030; C .08-.20; Mn .60; Si .50; Ni 8-10; Cr 17.5-20	35-45	80-90	65-55	S	A	C	B[5]	117
118	Ingersoll Stainless Steel Type 304	Ingersoll Steel & Disc, Chicago	S .030; P .030; C .08 max; Mn .60; Si .50; Ni 8-10; Cr 18-20	35-45	80-90	65-55	S	A	C	B[5]	118
119	Ingersoll Stainless Steel Type 316	Ingersoll Steel & Disc, Chicago	S .030; P .030; C .10 max; Mn .60; Si .50; Ni 10-14; Cr 16-18; Mo 2-3	35-50	80-90	65-55	S	A	C	B[5]	119
120	Ingersoll Stainless Steel Type 347	Ingersoll Steel & Disc, Chicago	S .030; P .030; C .10 max; Mn .60 Si .50; Ni 8-12; Cr 17-20; Cb 10 x C	35-45	80-90	60-55	S	A	C	B[5]	120
121	Ingersoll Stainless Steel Type 309	Ingersoll Steel & Disc, Chicago	S .030; P .030; C .20 max; Mn .60; Si .50; Ni 12-14; Cr 22-26	40-60	90-110	65-50	S	A	C	D	121
122	Inland Hi-Steel	Inland Steel Co., Chicago	S .05 max; P .05-.12; C .12 max; Mn .50-.90; Si .10 max; Ni .45-.65; Co .90-1.25	50	70	22	S, P, B	A	A	A	122
123	Jalloy 1	Jones & Laughlin Steel Corp., Pittsburgh, Pa.	C .13-.18; Mn 1.00-1.30; P .040 max; S .04 max; Si .15-.30; Mo .10-.20	67	91	26	S, P, B, Strip	A	A	A	123
124	Jalloy 3	Jones & Laughlin Steel Corp., Pittsburgh, Pa.	C .25-.31; Mn 1.35-1.65; P .040 max; S .040 max; Si .15-.30; Mo .10-.20	75	105	22.5	S, P, B, Strip	B	B	D	124
125	Jalloy 7	Jones & Laughlin Steel Corp., Pittsburgh, Pa.	C .50-.60; Mn 1.35-1.65; P .040 max; S .040 max; Si .15-.30; Mo .10-.20	90[15]	127	19.5	P, B	C	D	D	125
126	Jessop Silver-ply	Jessop Steel Co., Washington, Pa.	Carbon steel bonded integrally on one or both sides with various types of stainless steels.				S, P	A	C	B[5]	126
127	Keystone Chisel	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .45-.55; Mn .20-.35; Si .15-.25; Cr 1.00-1.20; W 1.80-2.10; V .10-.25.	158	168.3	13	S, P, B	B[8]	B[8]	D	127

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities ‡‡			No.
								Arc	Gas	Resistance	
128	Kutkwick	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .76-.80; Mn .20-.30; Si .20-.30; Cr 3.50-4.00; W 17.5-19.0; V .75-1.20	228.7	252.4	3.65	S, P, B	C	C	C	128
129	Lo-Cro 46 Mo 501 (now known as Rezistal 501)	Crucible Steel Co. of America, N.Y.	C over 0.10; Cr 4-6; Mo 0.40-0.60	25-35	60-145	40-30	S, P	A	X	B[13]	129
130	Low-Carbon-Nickel A-203-A	Lukens Steel Co., Coatesville, Pa.	S .027; P .016; C .16; Mn .65; Si .19; Ni 2.40	41	72.5	35	P	A	A	A	130
131	Low-Carbon-Nickel A-203-B	Lukens Steel Co., Coatesville, Pa.	S .030; P .015; C .19; Mn .70; Si .22; Ni 2.61	43	77	32	P	B[9]	B[9]	B[9]	131
132	Low-Carbon-Nickel A-203-C	Lukens Steel Co., Coatesville, Pa.	S .028; P .016; C .23; Mn .73; Si .20; Ni 2.51	49	85	29	P	B[10]	B[10]	B[10]	132
133	Low-Chromium-Molybdenum	Lukens Steel Co., Coatesville, Pa.	S .027; P .021; C .15; Mn .81; Si .20; Cr .42; Mo .23	43.5	73	31	P	A	A	A	133
134	Manganese Molybdenum	Lukens Steel Co., Coatesville, Pa.	S .040 max; P .030 max; C .20 max; Mn 1.20-1.50; Si .15-.30; Mo .40-.60	60	90-110	20	P, S, HR	A[11]	A[11]	A[11]	134
135	Manganese-Vanadium	Lukens Steel Co., Coatesville, Pa.	S .40 max; P .040 max; C .20 max; Mn 1.00-1.40; Si .15-.30; V .12 max	45	90	20	P, S, HR	A[11]	A[11]	A[11]	135
136	Manganese-Vanadium Titanium	Lukens Steel Co., Coatesville, Pa.	C .15 max; Mn 1.00-1.40; P .040 max; S .040 max; Si .15-.30; Ti .010 max; V .010 max	45	85	20	P, S, HR	A[11]	A[11]	A[11]	136
137	Mansil	Henry Disston & Sons, Phila., Pa.	S .025; P .025; C .85-.95; Mn 1.00-1.25; Si .25-.45; Cr .40-.60; W .40-.60	157.5	185.1	5.5	S, P, B	C	B[8]	D	137
138	Man-Ten	U.S. Steel Corp., Pittsburgh, Pa.	S .05 max; C .25 max; Mn 1.10-1.60; Si .30 max; Cu .20 min; P .04 max	50	75	20	S, P, HR, B	A	A	A	138
139	Mayari R	Bethlehem Steel Co., Bethlehem, Pa.	C 0.12 max; Mn 0.50-1.00; Si 0.10-0.50; Cu 0.50-0.70; Ni 0.25-0.75; P 0.08-0.12; Cr 0.40-1.00; S 0.05 max	50	70	22	S, P, CR, HR	A	A	A	139
140	50% Molybdenum	Lukens Steel Co., Coatesville, Pa.	C .20 max; Mn .60-.90; P .040 max; S .040 max; Si .15-.30; Mo .40-.60	50% T.S.	65-80	25	P, S, HR	A[11]	A[11]	A[11]	140

*Yield strength is that load which will produce an elongation of .002″ in 1″. The value is obtained from stress-strain curves, and is based on a 29,000,000 psi Modulus of Elasticity for steel, 6,500,000 psi for magnesium alloys, 10,300,000 psi for aluminum, 15,000,000 psi for brasses, 20,000,000 psi for 70/30 cupro-nickel.

**Single figure (50) indicates minimum value. Double figures (28-50) indicate range, which varies because of production processes or other causes; e.g., heat treatment, annealing, cold rolling, drawing, etc.

†Available forms: P = plates, S = sheets, CR = cold rolled, HR = hot rolled, B = bars, W = wire, T = tubing or pipe, R = rods.

‡‡Welding Qualities: A = Readily weldable. B = Weldable under favorable conditions (see footnotes). C = Not ordinarily weldable. D = No welding data available. X = This method of gas welding may be applied successfully to the chromium nickel and straight chromium alloys under certain conditions, but it is not as well adapted for general work with these alloys as is the metallic arc method. It is frequently employed on 20 gauge and lighter material.

5. Thin sections. 8. Preheat—cool slowly. 9. Low preheat 100-300 F is desired or recommended during welding. 10. Preheat during welding is required; the temperature during welding should be suitable for the composition and thickness of the material. 11. Low preheat 100-300 F is desired or recommended during welding in heavy sections. 12. Pickled surface required. 13. Heat treatment required. 15. Stress relieved at 1,100 F.

WELDABLE ALLOY MATERIALS—FERROUS

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
141	N-A-X High Tensile	Great Lakes Steel Corp. Ecorse, Detroit, Mich.	S .04 max; P .04 max; C .10-.18; Mn .50-.75; Si .70-.90; Cr .50-.65; Zn .10-.20; Mo .10-.20	50	70	30	S, P, CR, HR, B, W, T	A	A	A	141
142	2% Nickel	Lukens Steel Co., Coatesville, Pa.	C .20 max; Mn .80 max; P .040 max; S .040 max; Si .15-.70; Ni 2.00-2.50	50% T.S.	65-80	25	P, S, HR	A[11]	A[11]	A[11]	142
143	3½% Nickel	Lukens Steel Co., Coatesville, Pa.	C .20 max; Mn .80 max; P .040 max; Si .15-.30; Ni 3.25-3.75; S .040 max	50% T.S.	70-90	25	P, S, HR	A[11]	A[11]	A[11]	143
144	3½% Nickel	Alan Wood Steel Co., Conshohocken, Pa.	S .04 max; P .04 max; C .28-.33; Mn .60-.80; Si .15-.30; Ni 3.25-3.75	a	a	a	S, P	B[1]	D	D	144
145	8½% Nickel	Lukens Steel Co., Coatesville, Pa.	C .12 max; Mn .50-.80; P.040; S .040; Si .15-.30; Ni 8.00-9.00	70	90-110	20	P, S, HR	A[11]	A[11]	A[11]	145
146	Nickel-Chromium	Lukens Steel Co., Coatesville, Pa.	C .20 max; Mn .40-.60; P .040 max; S .040 max; Si .15-.30; Ni 1.00-1.20 Cr .40-.60	50	80-100	20	P, S, HR	A[11]	A[11]	A[11]	146
147	Nichroman	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .65-.75; Mn .35-.40; Si .10-.25; Ni 1.55-1.75; Cr .90-1.10; Cu .25-.45	186	206.9	6	S, P, B, Strip	B[8]	B[8]	D	147
148	Nivan	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .85-.95; Mn .25-.35; Si .20-.30, Ni 1.25-1.50; Cr .30-.45	138	182.1	8	S, P, CR, B	B[8]	B[8]	D	148
149	Otiscoloy	Jones & Laughlin Steel Corp., Pittsburgh, Pa.	S .040 max; C .15 max; Mn .90-1.40; Si 1.0 max; P .090-.135; Cu .30-.45	45-50	66-76	23-25	S, P, CR, B, Strip	A	A	A	149
150	Polaris	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .88; Mn .33; Si .34; Ni .75; Cr .26; V .07; Mo .16	140.8	179.5	10	S, P, CR, HR, B	B[8]	B[8]	B[8]	150
151	Republic Double Strength #1	Republic Steel Corp., Massillon, Ohio	S .04 max; P .04 max; C .12 max; Mn .50-1.0; Si .04 max; Ni .50-1.5; Cu .50-1.5; Mo .10 min	50	70	25	S, P, CR, B	A	A	A	151
152	Republic Double Strength #1 A	Republic Steel Corp., Massillon, Ohio	S .04 max; P .04 max; C .30 max; Mn .50-1.0; Si .04 max; Ni .50-1.5; Cu .50-1.5; Mo .10 min	70	90	15	S, P, CR, B	A[14]	D	B[14]	152
153	Rezistal 301	Crucible Steel Co. of America, New York	C over 0.08-0.15; Ni 6-8; Cr 16-18	35-45	105-110	60-55	S, P	A	X	B[13]	153
154	Rezistal 302	Crucible Steel Co. of America, New York	C over 0.08-0.15; Ni 8-10; Cr 17-19	35-45	90-95	60-50	S, P	A	X	B[13]	154
155	Rezistal 302B	Crucible Steel Co. of America, New York	C over 0.08-0.15; Si 2-3; Ni 8-10; Cr 17-19	35-45	90-100	60-50	S, P	A	X	A	155
156	Rezistal 303	Crucible Steel Co. of America, New York	C .015 max; Ni 8-10; Cr 17-19; Mo 0.60 max; S 0.07 min	30-40	90-100	60-50	S, P	A	X	B[13]	156
157	Rezistal 304	Crucible Steel Co. of America, New York	C 0.08 max; Ni 8-11; Cr 18-20	30-40	85-95	60-55	S, P	A	X	A	157
158	Rezistal 308	Crucible Steel Co. of America, New York	C 0.08 max; Ni 10-12; Cr 19-21	30-40	80-90	60-55	S, P	A	X	A	158
159	Rezistal 309	Crucible Steel Co. of America, New York	C 0.20 max; Ni 12-15; Cr 22-24	35-45	90-100	55-45	S, P	A	X	A	159
160	Rezistal 309B	Crucible Steel Co. of America, New York	C 0.20 max; Si 2-3; Ni 12-15; Cr 22-24	50-60	95-105	40-30	S, P	A	X	A	160
161	Rezistal 310	Crucible Steel Co. of America, New York	C 0.25 max; Ni 19-22; Cr 24-26	40-50	95-110	65-55	S, P	A	X	A	161
162	Rezistal 310B	Crucible Steel Co. of America, New York	C 0.25 max; Si 2-3; Ni 19-22; Cr 24-26	45-55	100-110	45-40	S, P	A	X	A	162

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
163	Rezistal 311	Crucible Steel Co. of America, New York	C 0.25 max; Ni 24-26; Cr 18-20	40-50	90-110	50-40	S, P	A	X	A	163
164	Rezistal 316	Crucible Steel Co. of America, New York	C 0.10 max; Ni 10-14; Cr 16-18; Mo. 175-2.75	35-45	85-90	60-50	S, P	A	X	A	164
165	Rezistal 317	Crucible Steel Co. of America, New York	C 0.10 max; Ni 10-14; Cr 17.5-20	35-45	85-95	50-40	S, P	A	X	A	165
166	Rezistal 321	Crucible Steel Co. of America, New York	C 0.10 max; Ni 8-11; Cr 17-19; Ti 5 x C min	30-40	85-90	55-50	S, P	A	X	A	166
167	Rezistal 325	Crucible Steel Co. of America, New York	C 0.30-0.50; Ni 19-23; Cr 7-10; Cu 1.-1.5	45-55	90-100	40-30	S, P	A	X	A	167
168	Rezistal 329	Crucible Steel Co. of America, New York	Ni 3-5; Cr 25-30; Mo 1.-1.5	85-95	105-125	30-20	S, P	A	X	A	168
169	Rezistal 347	Crucible Steel Co. of America, New York	C 0.10 max; Ni 9-12; Cr 17-19; Cb 10 x C min	35-45	90-95	55-45	S, P	A	X	A	169
170	Rezistal 403	Crucible Steel Co. of America, New York	C 0.15 max; Cr 11.5-13	35-45	65-85	35-25	S, P	B	X	B[13]	170
171	Rezistal 410	Crucible Steel Co. of America, New York	C 0.15 max; Cr 11.50-13.50	35-40	65-75	35-25	S, P	A	X	A	171
172	Rezistal 414	Crucible Steel Co. of America, New York	C 0.15 max; Ni 1.25-2.5; Cr 11.5-13.5	80-105	100-120			B	X	B[13]	172
173	Rezistal 420	Crucible Steel Co. of America, New York	C over 0.15; Cr 12-14	60-70	95-105	30-25	S, P	B	X	B[13]	173
174	Rezistal 430	Crucible Steel Co. of America, New York	C 0.12 max; Cr 14-18	35-45	75-85	40-30	S, P	A	X	B[15]	174
175	Rezistal 431	Crucible Steel Co. of America, New York	C 0.20 max; Ni 1.00 max; Cr 15-17	80-100	105-120	30-20	S, P	A	X	B[15]	175
176	Rezistal 440A	Crucible Steel Co. of America, New York	C .60-.70; Cr 16-18	50-60	90-100	35-25	S, P	B	X	B[13]	176
177	Rezistal 442	Crucible Steel Co. of America, New York	C 0.25 max; Cr 18-23	35-45	75-85	30-20	S, P	A	X	B[13]	177
178	Rezistal 446	Crucible Steel Co. of America, New York	C 0.35 max; Cr 23-27	50-55	80-90	30-20	S, P	A	X	B[13]	178
179	Rezistal 501	Crucible Steel Co. of America, New York	C over 0.10; Cr 4-6; Mo 0.40-0.60	25-35	60-145	40-30	S, P	A	X	B[13]	179
180	Rezistal 502	Crucible Steel Co. of America, New York	C 0.10 max; Cr 4-6; Mo 0.40-0.60	25-35	60-80	40-30	S, P	A	X	B[13]	180
181	Stainless Clad Steels‡	Lukens Steel Co., Coatesville, Pa.	Chromium-nickel types; chromium types	33	55-65	30	P, S, HR	A	C	B[16]	181
182	Stainless A	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .25; Ni 1.3; Cr 13.71	148.5	174.2	4	S, P, B, Strip	B[8]	B[8]	D	182
183	Stainless B	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .50-.60; Mn .20-.40; Si .25-.35; Cr 16-17	107.5	148.4	9.5	S, P, B, Strip	C	C	D	183
184	Stainless D	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .44; Mn .26; Si .96; Cr 8.77; Mo 1.84; Cu 1.83	168	227	11.3	S, P, Strip	C	B[8]	D	184
185	Stainless Iron	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .10; Mn .43; Si .41; Ni .41; Cr 15.18	103.1	121	21	S, P, B	B[8]	B[8]	B[8]	185

*Yield strength is that load which will produce an elongation of .002″ in 1″. The value is obtained from stress-strain curves, and is based on a 29,000,000 psi Modulus of Elasticity for steel, 6,500,000 psi for magnesium alloys, 10,300,000 psi for aluminum, 15,000,000 psi for brasses, 20,000,000 psi for 70/30 cupro-nickel.

**Single figure (50) indicates minimum value. Double figures (28-50) indicate range, which varies because of production processes or other causes; e.g., heat treatment, annealing, cold rolling, drawing, etc.

†Available forms: P=plates, S=sheets, CR=cold rolled, HR=hot rolled, B=bars, W=wire, T=tubing or pipe, R=rods.

‡Additional data on Lukens Stainless Clad Steels are listed on page 77.

‡‡Welding Qualities: A=Readily weldable. B=Weldable under favorable conditions (see footnotes). C=Not ordinarily weldable. D=No welding data available. X=This method of gas welding may be applied successfully to the chromium nickel and straight chromium alloys under certain conditions, but it is not as well adapted for general work with these alloys as is the metallic arc method. It is frequently employed on 20 gauge and lighter material.

a. Nickel Steel to A.S.T.M. Specs.

1. The necessity for stress relief annealing usually depends on the character of part and service. Adequate preheat can confer practically the same metallurgical advantages as postheating. 8. Preheat—cool slowly. 11. Low preheat 100-300 F is desired or recommended during welding in heavy sections. 13. Heat treatment required. 14. Stress relieve after welding. 15. Impact strength increased by annealing. 16. Spot welding only.

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
186	Stainless Steel 301	The stainless steels are grouped here in accordance to type numbers assigned by the American Iron and Steel Institute. According to reports of this survey these stainless steels are generally available from the following producers: Allegheny-Ludlum Steel Corp., Pittsburgh, Pa. American Rolling Mill Co., Middletown, Ohio Henry Disston & Sons, Tacony, Phila., Pa. Ingersoll Steel Div., Borg-Warner Corp., Chicago, Ill. Lukens Steel Co., Coatesville, Pa. Republic Steel Corp., Massillon, Ohio U.S. Steel Corp., Pittsburgh, Pa.	Fe; Cr 16-18; Ni 6-8; C 0.09-0.20; Mn 2.00 max	35-45	90-110	55-45	S, P, CR, HR, B, W	B[16]	X	A	186
187	Stainless Steel 302		Fe; Cr 17-19; Ni 8-10; C 0.09-0.20; Mn 2.00 max	35-45	80-110	65-55	S, P, CR, HR, B, W, T	A	X	A	187
188	Stainless Steel 302B		Fe; Cr 17-19; Ni 8-10; C .09-.20; Si 2-3; Mn 2.00 max	40-50	80-100	60-50	S, P, CR, HR, B, W	D	X	B[1]	188
189	Stainless Steel 303		Cr 17-19; Ni 8-10; C 0.2 max S or Se .07 min; Mo .60 max; Mn 2 max	35-45	80-90	60-50	S, P, CR, HR, B, W	D	X	B[1]	189
190	Stainless Steel 304		Fe; Cr 18-20; Ni 8-10; C 0.08 max; Mn 2.0 max	30-40	75-85	65-55	S, P, CR, HR, B, W, T	A	X	A	190
191	Stainless Steel 308		Fe; Cr 19-22; Ni 10-12; C 0.08 max; Mn 2 max	30-40	80-100	60-50	S, P, CR, HR, B, W, T	A	X	A	191
192	Stainless Steel 309		Cr 22-26; Ni 12-13; C .20 max; Mn 2 max	40-50	90-100	50-40	S, P, CR, HR, B, W	B[16]	X	A	192
193	Stainless Steel 310		Cr 24-26; Ni 19-21; C .25 max; Mn 2 max	40-55	90-110	50-40	S, P, CR, HR, B, W, T	A	X	A	193
194	Stainless Steel 311		Cr 18-20; Ni 24-26; C .25 max; Mn 2 max	45-50	90-110	40-30	S, P, CR, HR, B, W	A	X	A	194
195	Stainless Steel 316		Cr 16-18; Ni 10-14; C .10 max; Mn 2. max; Mo 2-3	35-45	80-100	60-50	S, P, CR, HR, B, W, T	A	X	A	195
196	Stainless Steel 317		Cr 17.5-20; Ni 10-14; C .10 max; Mo 3-4; Mn .2 max	40-50	90-100	50-40	S, P, CR, HR, B, W, T	A	X	A	196
197	Stainless Steel 321		Cr 17-19; Ni 8-12; C .10 max; Ti min 4 x C; Mn 2. max	30-40	80-90	60-50	S, P, CR, HR, B, W, T	A	B[16]	A	197
198	Stainless Steel 325		Cr 7-10; Ni 19.3-23.5; C .50 max; Cu 1-1.5	45-55	85-95	40-30	S, P, CR, HR, B, W	A	X	A	198
199	Stainless Steel 329		Cr 23-28; Ni 2.5-5; C .20 max; Mo 1-1.5	75	100	20	S, P, CR, HR, B, W	A	X	A	199
200	Stainless Steel 347		Cr 17-19; Ni 8-12; C .10 max; Cb 10 x C min; Mn 2. max	35-45	85-95	55-45	S, P, CR, HR, B, W, T	A	B[16]	A	200
201	Stainless Steel 403		Cr 11.5-13; C 0.15 max	30-40	60-85	35-25	S, P, CR, HR, B, W, T				201
202	Stainless Steel 410		Cr 10-14; C 0.15 max	30-40	60-75	35-25	S, P, CR, HR, B, W, T	B[16]	X	B[4]	202
203	Stainless Steel 414		Cr 10-14; Ni 2.5 max; C .15 max	113	128	20	S, P, HR, B, W	B[16]	X	B[4]	203
204	Stainless Steel 416		Cr 12-14; C 0.15 max; S or Se 0.07 min; Mo 0.06 max	40-60	70-85	35-25	S, P, CR, HR, B, W, T	D	X	D	204
205	Stainless Steel 420		Cr 12-14; C over .15	55-185	105-225	23-8	S, P, CR, HR, B, W	B[16]	X	B[7]	205
206	Stainless Steel 420F		Cr 12-14; C over .15; S or Se 0.07 min; Mo 0.60 max	76	134	6-7		B[16]	X	B[4]	206
207	Stainless Steel 430		Cr 14-18; C 0.12 max	40-50	70-80	30-20	S, P, CR, HR, B, W, T	B[16]	X	B[4]	207
208	Stainless Steel 430F		Cr 14-18; C 0.12 max; S or Se 0.07 min; Mo 0.60 max	40-55	70-85	30-20	CR, HR, B, W	D	X	D	208
209	Stainless Steel 440		Cr 14-18; C over .12	60-190	100-250	23-3	S, CR, HR, B, W	D	X	D	209
210	Stainless Steel 441		Cr 14-18; Ni 2.5 max; C over .20	186	235	6	S, P, CR, HR, B, W	D	X	B[4]	210

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
211	Stainless Steel 442	(See this column p. 74 preceding)	Cr 18-23; C 0.35 max	45-55	75-85	30-20	S, P, CR, HR, B	B[16]	X	B[4]	211
212	Stainless Steel 446		Cr 23-30; C 0.35 max	50-60	80-90	30-20	S, P, CR, HR, B, W, T	B[16]	X	B[4]	212
213	Stainless Steel 501		Cr 4-6; C over .10	30-40	65-75	35-25	S, P, CR, HR, B, W, T	B[16]	X	B[4]	213
214	Stainless Steel 502		Cr 4-6; C 0.10 max	30-40	65-75	35-25	S, P, CR, HR, B, W, T	B[16]	X	B[4]	214
215	SAE 3135	Alan Wood Steel Co., Conshohocken, Pa.	S .05 max; P .04 max; C .35; Mn .65; Si .25; Ni 1.25; Cr 60.	t	t	t	S, P	B[1]	B[1]	B[1]	215
216	SAE X 4130	Republic Steel Co., Massillon, Ohio‡	S 0.05 max; P 0.04 max; C .25-.35; Mn .40-.60; Cu .80-1.10; Mo .15-.25	100	125	18	S, P, B, W	B[14]	B[14]	D	216
217	U.S.Army 57-136-8-c(d) U.S.Navy 47-S-14-b	U.S. Steel Corp., Pittsburgh, Pa.	S .045 max; P .040 max; C .25-.35; Mn .40-.60; Si .15-.30; Cr .80-1.10; Mo .15-.25	70	90	20-10	S, P, B	B[1]	B[6]	D	217
218	U.S.Navy 46-S-1 (INT) Grade H.T. Welding	U.S. Steel Corp., Pittsburgh, Pa.	S .05 max; P .04 max; C .18 max; Mn 1.45 max; Si .25 max; Si .25 max; V .08-.14; Cu .25 max	50	90 max.	25	HR, B, W	A	D	D	218
219	U.S.Navy 48-S-5 Int.e Grade H.T. Welding (d)	U.S. Steel Corp., Pittsburgh, Pa.‡	S .050 max; P .040 max; C .18 max; Mn 1.45 max; Si .25 max; Ni .25 max; V .08-.14; Cu .25 max	50	90 max.	22	S, P, HR, CR, B	A	D	D	219
220	U.S.S. 17	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .040 max; C .12 max; Mn 1.00 max; Si 1.00 max; Ni .50 max; Cr 14-18	40-55	70-90	30-20	S, P, HR, CR, B, W, T, R	B[16]	B[16]	A	220
221	U.S.S. 17-7	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .040 max; C over 0.08; Mn 2.00 max; Si 1.00 max; Ni 6-8; Cr 16-18	35-140	110-185	60-5	S, W	B[18]	B[18]	A	221
222	U.S.S. 18-8	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .040 max; C .08-.20; Mn 2.00 max; Si 1.00 max; Ni 8-10; Cr 17-19	30-45	75-95	60-50	S, P, HR, CR, B, W, R	A[18]	A[18]	A	222

*Yield strength is that load which will produce an elongation of .002″ in 1″. The value is obtained from stress-strain curves, and is based on a 29,000,000 psi Modulus of Elasticity for steel, 6,500,000 psi for magnesium alloys, 10,300,000 psi for aluminum, 15,000,000 psi for brasses, 20,000,000 psi for 70/30 cupro-nickel.

**Single figure (50) indicates minimum value. Double figures (28-50) indicate range, which varies because of production processes or other causes; e.g., heat treatment, annealing, cold rolling, drawing, etc.

†Available forms: P=plates, S=sheets, CR=cold rolled, HR=hot rolled, B=bars, W=wire, T=tubing or pipe, R=rods.

‡‡Welding Qualities: A=Readily weldable. B=Weldable under favorable conditions (see footnotes). C=Not ordinarily weldable. D=No welding data available. X=This method of gas welding may be applied successfully to the chromium nickel and straight chromium alloys under certain conditions, but it is not as well adapted for general work with these alloys as is the metallic arc method. It is frequently employed on 20 gauge and lighter material.

‡Also available from Alan Wood Steel Co., Conshohocken, Pa.

d. Chrome Moly to U.S. Army or Navy Specs.

t. Used as furnished.

1. The necessity for stress relief annealing usually depends on the character of part and service. Adequate preheat can confer practically the same metallurgical advantages as post heating. 4. Annealing suggested to remove brittleness and to improve ductility. 6. Post heat. 14. Stress relieve after welding. 16. Use austenitic rod; e.g., 17 CR rod annealed. 18. Annealing necessary for maximum resistance to corrosion.

WELDABLE ALLOY MATERIALS—FERROUS

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
223	U.S.S. 18-8S	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .040 max; C .08 max; Mn 2.00 max; Si 1.00 max; Ni 8-10; Cr 18-20	30-45	80-95	60-50	S, P, HR, CR, B, W, T, R	A[18]	A[18]	A	223
224	U.S.S. 18-8 Mo	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .040 max; C .10 max; Mn 2.00 max; Si .75 max; Ni 10-14 Cr 16-18; Mo 1.75-2.50	30-45	80-95	60-40	S, P, HR, CR, B, W, T, R	A[18]	A[18]	A	224
225	U.S.S. 18-8 Ti	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .040 max; C .10 max; Mn 2.00 max; Si 1.00 max; Ni 8-11; Cr 17-19; Ti 4 x C min	30-45	75-95	55-45	S, P, HR, CR, B, W, T, R	A	A	A	225
226	U.S.S. 18-8 Cb	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .040 max; C .10 max; Mn 2.00 max; Si 1.00 max; Ni 9-12; Cr 17-19; Cb 10 x C min	35-50	80-100	50-35	S, P, HR, CR, B, W, T, R	A	A	A	226
227	U.S.S. 25-12	U.S. Steel Corp., Pittsburgh, Pa.	S .040 max; P .040 max; C .20 max; Mn 2.00 max; Si 1.00 max; Ni 12-15; Cr 22-24	35-50	80-100	50-40	S, P, HR, CR, B, W, T, R	A	A	A	227
228	U.S.S. 5	U.S. Steel Corp., Pittsburgh, Pa.	C over .10; Mn 1.00 max; P .04 max; S .04 max; Si 1.00 max; Cr 4-6	25-45	65-85	35-25	S, P, T, W, B	B	B	B	228
229	U.S.S. 5-S	U.S. Steel Corp., Pittsburgh, Pa.	C .10 max; Mn 1.00 max; P .04 max; S .04 max; Si 1.00 max; Cr 4-6	25-45	65-85	35-25	S, P, T, W, B	B	B	B	229
230	U.S.S. 12	U.S. Steel Corp., Pittsburgh, Pa.	C .15 max; Mn 1.00 max; P .04 max; S .04 max; Si 1.00 max; Cr 11.5-13.5	35-45	65-85	35-20	S, P, T, W, B	B	B	B	230
231	U.S.S. 12al	U.S. Steel Corp., Pittsburgh, Pa.	C .08 max; Mn 1.00 max; P .04 max; S .04 max; Si 1.00 max; Cr 11.5-13.5; Al .10-.30	35-45	60-85	35-20	S, P, B	A	B	B	231
232	U.S.S. 27	U.S. Steel Corp., Pittsburgh, Pa.	C .35 max; Mn 1.00 max; P .04 max; S .04 max; Cr 23-27	45-60	75-95	30-20	S, P, T, B, W	B	B	B	232
233	Va Tool	Henry Disston & Sons, Tacony, Phila., Pa.	S .025; P .025; C .90-1.00; Mn .15-.30; Si .10-.20; V .20-.30	183.8	203.6	6.5	S, P, B, Strip	A	A	B	233
234	Yoloy .10% Carbon	Youngstown Sheet & Tube, Youngstown, Ohio	S .05; P .04; C .10; Mn .40; Ni 1.00 min; Cu .75 min	50	70	35	S, P, CR, HR, B, W, T	A	A	A[21]	234
235	Yoloy .15% Carbon	Youngstown Sheet & Tube, Youngstown, Ohio	S .05; P .04; C .15; Mn .65; Si .15; Ni 1.00 min; Cu .75 min	56	77	30	S, P, CR, HR, B, W, T	A	A	A[21]	235
236	Yoloy .20% Carbon	Youngstown Sheet & Tube, Youngstown, Ohio	S .05; P .04; C .20; Mn .80; Si .15; Ni 1.00 min; Cu .75 min	62 Note 19 Notes 19,20	85 Note 19 Notes 19,20	25 Note 19 Notes 19,20	S, P, CR, HR, B, W, T	A	A	A[21]	236
237	Yoloy (High Carbon)	Youngstown Sheet & Tube, Youngstown, Ohio	S .05; P .04; C .40; Mn 1.25; Si .35; Ni 2.25; Cu 1.25				S, P, CR, HR, B, W, T, R	B	B	B[21]	237
238	Yoloy (Low Carbon)	Youngstown Sheet & Tube, Youngstown, Ohio	S .05; P .07; C .20; Mn .90; Ni 2.25; Cu 1.25				S, P, CR, HR, B, W, T, R	A	A	A	238

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
181	Stainless Clad Steels (supplementing information listed on page 73)										
	Chromium-Nickel 304, non-hardenable austenitic	Lukens Steel Co., Coatesville, Pa.	C .08 max; Mn 2.0; Si 1.0; P .04; S .04; Cr 18.0-20.0; Ni 8.0-10.0								
	Chromium-Nickel 316, non-hardenable austenitic	Lukens Steel Co., Coatesville, Pa.	C .10 max; Mn 2.0; Si 1.0; P .04; S .04; Cr 16.0-18.0; Ni 10.0-14.0; Mo 1.75-2.50								
	Chromium-Nickel 347, non-hardenable austenitic	Lukens Steel Co., Coatesville, Pa.	C .10 max; Mn 2.0; Si 1.0; P .04; S .04; Cr 17.0-14.0; Ni 9.0-12.0; Cb 8 x C min	See page 73, No. 181, for Tensile Properties and Welding Qualities							
	Chromium 410, martensitic, hardenable	Lukens Steel Co., Coatesville, Pa.	C .15 max; Mn 1.0; Si 1.0; P .04; S .04; Cr 11.5-13.5								
	Chromium 430, ferritic, non-hardenable	Lukens Steel Co., Coatesville, Pa.	C .12 max; Mn 1.0; Si 1.0; P .04; S .04; Cr 14.0-18.0								

*Yield strength is that load which will produce an elongation of .002″ in 1″. The value is obtained from stress-strain curves, and is based on a 29,000,000 psi Modulus of Elasticity for steel, 6,500,000 psi for magnesium alloys, 10,300,000 psi for aluminum, 15,000,000 psi for brasses, 20,000,000 psi for 70/30 cupro-nickel.

**Single figure (50) indicates minimum value. Double figures (28-50) indicate range, which varies because of production processes or other causes; e.g., heat treatment, annealing, cold rolling, drawing, etc.

†Available forms: P=plates, S=sheets, CR=cold rolled, HR=hot rolled, B=bars, W=wire, T=tubing or pipe, R=rods.

‡‡Welding Qualities: A=Readily weldable. B=Weldable under favorable conditions (see footnotes). C=Not ordinarily weldable. D=No welding data available. X=This method of gas welding may be applied successfully to the chromium nickel and straight chromium alloys under certain conditions, but it is not as well adapted for general work with these alloys as is the metallic arc method. It is frequently employed on 20 gauge and lighter material.

‡Also available from Alan Wood Steel Co., Conshohocken, Pa.

a. Nickel Steel to A.S.T.M. Specs., b. Carbon Moly to A.S.T.M. Specs., c. Manganese Vanadium to A.S.T.M. Specs., d. Chrome Moly to U.S. Army or Navy Specs., e. Manganese Vanadium to U.S. Navy Specs.

t. Used as furnished.

1. The necessity for stress relief annealing usually depends on the character of part and service. Adequate preheat can confer practically the same metallurgical advantages as post heating. 2. Can be flash welded. 3. Preheat during welding is required; the temperature during welding should be suitable for the composition and thickness of the material. Special welding technique required also. 4. Annealing suggested to remove brittleness and to improve ductility. 5. Thin sections. 6. Post heat. 7. Unable to make ductile. 8. Preheat—cool slowly. 9. Low preheat 100-300 F is desired or recommended during welding. 10. Preheat during welding is required; the temperature during welding should be suitable for the composition and thickness of the material. 11. Low preheat 100-300 F is desired or recommended during welding in heavy sections. 12. Pickled surface required. 13. Heat treatment required. 14. Stress relieve after welding. 15. Impact strength increased by annealing. 16. Use austenitic rod; e.g., 17 CR rod annealed. 17. Annealed. 18. Annealing necessary for maximum resistance to corrosion. 19. Tensile properties of these various grades vary widely depending on the composition, type of product, processing procedure and heat treatment involved and can be adjusted to meet the requirements of specific applications. 20. The normal tensile properties of low-alloy, high-tensile steels are included under this group. 21. Spot welding only.

This concludes the weldable ferrous alloys
On the pages to follow are listed the weldable non-ferrous alloys

WELDABLE ALLOY MATERIALS—NON-FERROUS

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡ Arc	Gas	Resistance	No.
239	Admiralty	Revere Copper & Brass, Inc., New York	Zn 28; Pb 0.075 max; Sn 1.0; Fe 0.06 max; Cu 71	16-20	40-50	65-55	S, P, SH, B, W, T	B[1]	B[2]	B[3]	239
240	Alcoa 2S-0	Aluminum Co. of America, Pittsburgh, Pa.	Al 99.6	5	13	35	S, P, SH, B, W, T, R	A	A	A	240
241	Alcoa 2S-H	Aluminum Co. of America, Pittsburgh, Pa.	Al 99.6	21	24	5	S, P, SH, B, W, T, R	A	A	A	241
242	Alcoa 3S-0	Aluminum Co. of America, Pittsburgh, Pa.	Mn 1.2; Al remainder	6	16	30	S, P, SH, B, W, T, R	A	A	A	242
243	Alcoa 3S-H	Aluminum Co. of America, Pittsburgh, Pa.	Mn 1.2; Al remainder	25	29	4	S, P, SH, B, W, T, R	A	A	A	243
244	Alcoa 17S-0	Aluminum Co. of America, Pittsburgh, Pa.	Cu 4.0; Mn 0.5; Mg 0.5; Al rem	10	26	20	S, P, SH, B, W, T, R, F	C	C	B[4]	244
245	Alcoa 17S-T	Aluminum Co. of America, Pittsburgh, Pa.	Cu 4.0; Mn 0.5; Mg 0.5; Al rem	40	62	20	S, P, SH, B, W, T, R, F	C	C	B[4]	245
246	Alcoa 24S-0	Aluminum Co. of America, Pittsburgh, Pa.	Cu 4.5; Mn 0.6; Mg 1.5; Al rem	10	26	20	S, P, SH, B, W, T, R	C	C	B[4]	246
247	Alcoa 24S-T	Aluminum Co. of America, Pittsburgh, Pa.	Cu 4.6; Mn 0.6; Mg 1.5; Al rem	45	68	19	S, P, SH, B, W, T, R	C	C	B[4]	247
248	Alcoa 24S-RT	Aluminum Co. of America, Pittsburgh, Pa.	Cu 4.6; Mn 0.6; Mg 1.5; Al rem	55	70	13	S, P, SH	C	C	B[4]	248
249	Alcoa 52S-0	Aluminum Co. of America, Pittsburgh, Pa.	Cr 0.25; Mg 2.5; Al rem	14	29	25	S, P, SH, B, W, T, R	A	A	A	249
250	Alcoa 52S-H	Aluminum Co. of America, Pittsburgh, Pa.	Cr 0.25; Mg 2.5; Al rem	36	41	7	S, P, SH, B, W, T, R	A	A	A	250
251	Alcoa 53S-0	Aluminum Co. of America, Pittsburgh, Pa.	Si 0.7; Cr 0.25; Mg 1.3; Al rem	7	16	25	S, P, SH, HR, B, W, T, R, F	A	A	A	251
252	Alcoa 53S-W	Aluminum Co. of America, Pittsburgh, Pa.	Si 0.7; Cr 0.25; Mg 1.3; Al rem	20	33	22	S, P, SH, HR, B, W, T, R, F	A	A	A	252
253	Alcoa 53S-T	Aluminum Co. of America, Pittsburgh, Pa.	Si 0.7; Cr 0.25; Mg 1.3; Al rem	33	39	14	S, P, SH, HR, B, W, T, R, F	A	A	A	253
254	Alcoa 61S-0	Aluminum Co. of America, Pittsburgh, Pa.	Cu 0.25; Si 0.6; Cr 0.25; Mg 1.0; Al rem	8	18	22	S, P, SH, HR, T	A	A	A	254
255	Alcoa 61S-W	Aluminum Co. of America, Pittsburgh, Pa.	Cu 0.25; Si 0.6; Cr 0.25; Mg 1.0; Al rem	21	35	22	S, P, SH, T	A	A	A	255
256	Alcoa 61S-T	Aluminum Co. of America, Pittsburgh, Pa.	Cu 0.25; Si 0.6; Cr 0.25; Mg 1.0; Al rem	39	45	12	S, P, SH, T	A	A	A	256
257	Alclad 24S-T	Aluminum Co. of America, Pittsburgh, Pa.	Alcoa 24S-T with high-purity Al coating	41	62	19	S, P	C	C	A	257
258	Aluminum 2S-0	Sheet Aluminum Corp., Jackson, Mich.	Al 99.6	5	13	35	S, P	D	A	A	258
259	Aluminum 2S¼H	Sheet Aluminum Corp., Jackson, Mich.	Al 99.6	13	15	12	S, P	D	A	A	259
260	Aluminum 2S½H	Sheet Aluminum Corp., Jackson, Mich.	Al 99.6	14	17	9	S, P	D	A	A	260
261	Aluminum 2S¾H	Sheet Aluminum Corp., Jackson, Mich.	Al 99.6	17	20	6	S, P	D	A	A	261
262	Aluminum 2SH	Sheet Aluminum Corp., Jackson, Mich.	Al 99.6	21	24	5	S, P	D	A	A	262
263	Ampco 12	Ampco Metal, Inc., Milwaukee	Cu 88.2; Al 8.; Fe 2.9	22	60	22-27	S, B	A	D	D	263
264	Ampco 16	Ampco Metal, Inc., Milwaukee	Cu 86.2; Al 10.2; Fe 3.3	35	75	18-22	S, B	A	D	D	264
265	Ampco 18	Ampco Metal, Inc., Milwaukee	Cu 84.6; Al 11.3; Fe 3.7	38	80	10-14	S, B	A	D	D	265
266	Brass (70-30)	Revere Copper & Brass, Inc., New York	Zn 30; Pb 0.05 max; Fe 0.05 max; Cu 70	13-17	40-50	55-45	S, P, HR, CR, B, T	B[1]	B[2]	B[3]	266
267	Brass, Cartridge	Chase Brass & Copper Co., Inc., Waterbury, Conn.	Cu 70; Zn .30	17	49	57	S, P, B, R, W, T	B	A	B	267
268	Brass, High	Revere Copper & Brass, Inc., New York	Cu 67; Zn 33	20	52	55	S, P, CR, B, T	C	A	B[5]	268
269	Brass, Naval	American Brass Co. (See Footnote ‡.)	Cu 60; Zn 39.25; Sn 0.75	30	55	40	S, P, CR, B	B[1]	A	B[5]	269
270	Brass, Red	American Brass Co. (See Footnote ‡.)	Cu 85; Zn 15	14	42	47	S, P, CR, B, W, T	B[1,5]	B[5,2]	C	270
271	Brass, Red, 85%	American Brass Co. (See Footnote ‡.)	Cu 85; Zn 15	15	40	45	S, P, CR, B, W, T	C	B[6]	C[7]	271
272	Brass, Yellow	American Brass Co. (See Footnote ‡.)	Cu 65; Zn 35	17	45	60	S, P, CR, B, W	C	B[8]	C	272
273	Bronze, Commercial	American Brass Co. (See Footnote ‡.)	Zn 10; Pb 0.03 max; Fe 0.05; Cu 90	9-13	32-42	45-35	S, P, HR, CR, B, W, T	B[1]	B[2]	C	273
274	Bronze, Roman	Revere Copper & Brass, Inc., New York	Zn 39.25; Pb 0.02 max; Sn 0.75; Fe 0.05 max; Cu 60	16-20	49-59	55-45	S, HR, CR, B, T	B[1]	B[2]	B[3]	274

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
275	Bronze, Manganese	American Brass Co. (See Footnote ‡.)	Cu 59; Zn 39.0; Sn 0.70; Mn 0.50; Fe 0.80	30	60	30	S, P, CR, HR, B, R	C	B[8]	C	275
276	Bronze, Tobin	Revere Copper & Brass, Inc., New York	Cu 60.0; Zn 39.25, Sn 0.75	22	56	45	S, P, CR, HR, B, R	C	B[8]	C	276
277	Deoxidized Copper	American Brass Co. (See Footnote ‡.)	Cu 99.9; P 0.02	10	33	35	S, P, CR, HR, B, W, T	B[6,9]	B[6,10]	C	277
278	30% Cupro-Nickel	American Brass Co. (See Footnote ‡.)	Cu 70; Ni 30	22	55	40	S, P, CR, HR, B, W, T	B	B	A	278
279	Cupro-Nickel 505	Revere Copper & Brass, Inc., New York	Pb 0.05 max; Fe 0.5 max; Cu 80; Ni 20; Mn 0.75	15-19	44-54	47-37	S, P, CR, B, T, R	B[11]	B[12]	A	279
280	Dowmetal FS-1	Dow Chemical Co., Midland, Mich.	Al 3.0; Mn 0.2; Zn 1.0; Mg remainder	30	40	15	B, R, T, SH	B[13]	B[14]	A	280
281	Dowmetal FS-1a	Dow Chemical Co., Midland, Mich.	Al 3.0; Mn 0.2; Zn 1.0; Mg remainder	22	37	21	P, S	B[13]	B[14]	A	281
282	Dowmetal FS-1h	Dow Chemical Co., Midland, Mich.	Al 3.0; Mn 0.2; Zn 1.0; Mg remainder	33	43	11	P, S, CR	B[13]	B[14]	A	282
283	Dowmetal J-1	Dow Chemical Co., Midland, Mich.	Al 6.5; Mn 0.2; Zn 1.0; Mg remainder	32	45	15	F, T, B, R, SH	B[13]	B[14]	A	283
284	Dowmetal J-S1a	Dow Chemical Co., Midland, Mich.	Al 4.8; Mn 0.2; Zn 0.9; Mg remainder	26	43	16	P, S	B[13]	B[14]	A	284
285	Dowmetal J-S1h	Dow Chemical Co., Midland, Mich.	Al 4.8; Mn 0.2; Zn 0.9; Mg remainder	34	47	9	P, S, CR	B[13]	B[14]	A	285
286	Dowmetal M	Dow Chemical Co., Midland, Mich.	Mn 1.5; Mg remainder	26	38	10	F, B, R, T, SH	B[13]	A	A	286
287	Dowmetal Ma	Dow Chemical Co., Midland, Mich.	Mn 1.5; Mg remainder	15	33	17	S, P	B[13]	A	A	287
288	Dowmetal Mh	Dow Chemical Co., Midland, Mich.	Mn 1.5; Mg remainder	29	37	8	S, P, CR	B[13]	A	A	288
289	Dowmetal O-1	Dow Chemical Co., Midland, Mich.	Mn 0.2; Al 8.5; Zn 0.5; Mg remainder	33	49	11	SH, B, R, F	B[13]	B[14]	A	289
290	Dowmetal O-1a	Dow Chemical Co., Midland, Mich.	Al 8.5; Mn 0.2; Zn 0.5; Mg remainder	34	50	5	F	B[13]	B[14]	A	290
291	Dowmetal O-1HTA	Dow Chemical Co., Midland, Mich.	Al 8.5; Mn 0.2; Zn 0.5; Mg remainder	41	54	8	F, B, R, SH	B[13]	B[14]	A	291
292	Everdur 1010	American Brass Co., Waterbury, Conn.	Cu 95.8; Mn 1.1; Si 3.1	20	55	60	S, P, CR, B, W, T, R	A	A	A	292
293	Everdur 1015	American Brass Co., Waterbury, Conn.	Cu 98.25; Si 1.50; Mn .25.	15	40	45	S, P, HR, CR, B, W, T, R	B[15]	B[16]	B[17]	293
294	Herculoy 418	Revere Copper & Brass, Inc., New York	Si 3.0; Pb 0.02 max; Sn 0.5; Fe 0.10 max; Cu rem	22-26	55-65	70-60	S, P, HR, CR, B	A[15]	A[16]	A[17]	294
295	Herculoy 419	Revere Copper & Brass, Inc., New York	Si 1.75; Pb 0.02 max; Sn 0.25; Fe 0.10 max; Cu rem	20-24	40-50	70-60	S, P, HR, CR, B	B[15]	B[16]	B[17]	295
296	Herculoy 420	Revere Copper & Brass, Inc., New York	Mn 1.0; Si 3.0; Pb 0.02 max; Fe 0.10 max; Cu rem	22-26	55-65	70-60	S, P, HR, CR, B, T	A[15]	A[16]	A[17]	296

*Yield strength is that load which will produce an elongation of .005″ in 1″. The value is obtained from stress-strain curves, and is based on a 25,000,000 psi Modulus of Elasticity for malleable iron, 6,500,000 psi for magnesium alloys, 10,300,000 psi for aluminum, 15,000,000 psi for brasses, 20,000,000 psi for 70/30 cupro-nickel.

**Single figure (50) indicates minimum value. Double figures (28-50) indicate range, which varies because of production processes or other causes; e.g., heat treatment, annealing, cold rolling, drawing, etc.

†Available forms: P = plates, S = sheets, SH = rolled or extruded shapes, CR = cold rolled, HR = hot rolled, B = bars, W = wire, T = tubing or pipe, R = rods, F = forgings.

‡‡Welding Qualities: A = Readily weldable. B = Weldable under favorable conditions (see footnotes). C = Not ordinarily weldable. D = No welding data available. E = Welding in experimental stage.

‡Also available from Chase Brass and Copper Co. and Revere Copper and Brass, Inc. Chase and Revere products may differ slightly in chemical compositions and/or tensile properties from those given here.

1. Carbon arc: play on zinc free filler rod of silicon or phosphor bronze types; 700-1000 F. preheat desirable for heavier gauges. 2. Slightly oxidizing flame desirable with filler rods or strips of base metal composition, or with "bronze" welding rods. 3. Accurate control over pressure, time and heat necessary. 4. Mild corrosion conditions only. 5. Consult producer. 6. High heat required. 7. A special high silicon red brass having an "A" rating for resistance spot and seam welding is available. 8. Oxidizing flame. 9. Metallic arc: coated electrode and 700-900 F. preheat. Carbon arc: silicon or phosphor bronze filler rods and 500-900 F. preheat. 10. Adequate preheat and deoxidized filler rod. 11. Coated cupro-nickel electrodes. 12. Usually employed for thinner gauges; reducing flame necessary to prevent formation of refractory nickel oxide; flux recommended. 13. Weldable in a helium atmosphere. 14. Limited to simple structures. 15. Carbon arc: silicon bronze filler rods; flux necessary; arc length and manipulation of carbon electrode both important. 16. Slightly oxidizing flame recommended; flux necessary; "hot shortness" of alloys necessitates care to prevent cracking of "closed structure" type welds. 17. Surface must be free of silicon oxide; accurate control over variables necessary.

WELDABLE ALLOY MATERIALS — NON-FERROUS

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
297	Herculoy 421	Revere Copper & Brass, Inc., New York.	Mn 0.3; Si 1.75; Pb 0.02 max; Fe 0.10 max; Cu rem	20-24	40-50	70-60	S, P, HR, CR, B, T	B[15]	B[16]	B[17]	297
298	Hyblum AAO	Sheet Aluminum Corp., Jackson, Mich.	Mn 0.12; Si 0.45; Ni 0.70; Cu 0.23	11	20	25	S, P	D	A	A	298
299	Hyblum AA¼H	Sheet Aluminum Corp., Jackson, Mich.	Mn 0.12; Si 0.45; Ni 0.70; Cu 0.23	22	24	6.5	S, P	D	A	A	299
300	Hyblum AA½H	Sheet Aluminum Corp., Jackson, Mich.	Mn 0.12; Si 0.45; Ni 0.70; Cu 0.23	25	26	4	S, P	D	A	A	300
301	Hyblum AA¾H	Sheet Aluminum Corp., Jackson, Mich.	Mn 0.12; Si 0.45; Ni 0.70; Cu 0.23	27	28	3	S, P	D	A	A	301
302	Hyblum AAH	Sheet Aluminum Corp., Jackson, Mich.	Mn 0.12; Si 0.45; Ni 0.70; Cu 0.23	32	33	3	S, P	D	A	A	302
303	Hyblum BO	Sheet Aluminum Corp., Jackson, Mich.	Mn 0.05; Si 0.45; Ni 0.30; Cu 0.10	8.6	16	25	S, P	D	A	A	303
304	Hyblum B¼H	Sheet Aluminum Corp., Jackson, Mich.	Mn 0.05; Si 0.45; Ni 0.30; Cu 0.10	17	21	9	S, P	D	A	A	304
305	Hyblum B½H	Sheet Aluminum Corp., Jackson, Mich.	Mn 0.05; Si 0.45; Ni 0.30; Cu 0.10	20	22	5	S, P	D	A	A	305
306	Hyblum B¾H	Sheet Aluminum Corp., Jackson, Mich.	Mn 0.05; Si 0.45; Ni 0.30; Cu 0.10	23	25	3	S, P	D	A	A	306
307	Hyblum BH	Sheet Aluminum Corp., Jackson, Mich.	Mn 0.05; Si 0.45; Ni 0.30; Cu 0.10	26	27	2	S, P	D	A	A	307
308	Hyblum DO18	Sheet Aluminum Corp., Jackson, Mich.	Mn 0.16; Si 0.45; Ni 1.00; Cu 0.32; Mg 0.40	37	43	12	S, P	D	A	A	308
309	Illium "R" (Annealed)	Burgess-Parr Company Freeport, Illinois	C 0.2 max; Mn 1-2; Si 0.65 max; Ni 55-58; Cr 22-24; Cu 3-7; Mo 5-7; Fe 5-7	45-55	95-105	30-45	S, P, CR, HR, B, W, T, R	A	B[18]	A	309
310	Illium "R" (Work Hardened)	Burgess-Parr Company Freeport, Illinois	C 0.2 max; Mn 1-2; Si 0.65 max; Ni 55-58; Cr 22-24; Cu 3-7; Mo 5-7; Fe 5-7	60-100	105-150	12-3	S, P, CR, HR, B, W, T, R	A	B[18]	A	310
311	Inconel	International Nickel Co., Inc., New York	S 0.015; C 0.08; Mn 0.25; Si 0.25; Ni 79.5; Cr 13.0; Cu 0.2; Fe 6.5	30-45	80-100	50-35	S, P, CR, HR, B, W, T, R	A	A	A	311
312	Inconel-Clad Steel	Lukens Steel Co., Coatesville, Pa.	Ni 79.5; Cr 13; Fe 6.5; Mn 0.25; Si 0.25; C .08; Cu .20	50	55-65	30	S, P, HR	A	C	B[19]	312
313	Mazlo AM3S	American Magnesium Corp., Cleveland, O.	Mn 1.5; Mg remainder	16-30	32-40	17-7	S, P, SH, CR, HR, B, W, T, F	B[13]	A	A[20]	313
314	Mazlo AM-C52S	American Magnesium Corp., Cleveland, O.	Mn 0.2; Al 3.0; Zn 1.0; Mg remainder	22-33	35-42	21-11	S, P, SH, CR, HR, B, T	B[13]	A	A[20]	314
315	Mazlo AM-C54S	American Magnesium Corp., Cleveland, O.	Mn 0.2; Al 4.8; Zn 0.9; Mg remainder	22-34	40-44	20-8	S, P, HR, CR	B[13]	A	A	315
316	Mazlo AM-C57S	American Magnesium Corp., Cleveland, O.	Mn 0.2; Al 6.5; Zn 1.0; Mg remainder	22-32	40-44	15-10	SH, B, W, T, F	B[13]	B[21]	A[20]	316
317	Monel	International Nickel Co., New York, N. Y.	S 0.01; C 0.15; Mn 1.0; Si 0.1; Ni 67.0; Cu 30.0; Fe 1.4	25-45	65-85	50-20	S, P, CR, HR, B, W, C, T, R	A	A	A	317
318	Monel "K"	International Nickel Co., New York, N. Y.	S 0.005; C 0.15; Mn 0.85; Si 0.50; Ni 66.0; Cu 29.0; Fe 0.90; Al 2.75	40-65	90-110	45-25	S, CR, HR, B, W, T, R	A	A	A	318
319	Monel-Clad Steel	Lukens Steel Co., Coatesville, Pa.	Ni 67.; Cu 30.; Fe 1.4; Mn 1.0; C 0.15; Si 0.1	50	55-65	30	S, P, HR	A	C	B[19]	319
320	Muntz Metal	American Brass Co. (See Footnote ‡.)	Zn 40; Pb 0.30 max; Fe 0.07 max; Cu 60	13-17	52-62	53-43	S, P, HR, CR, B, W, T	B[1]	B[2]	B[3]	320
321	Nickel	International Nickel Co., New York, N. Y.	S .005; C 0.1; Mn 0.2; Si 0.05; Ni 99.4; Cu 0.1; Fe 0.15	15-30	60-80	50-35	S, P, CR, HR, B, W, C, T, R	A	A	A	321
322	Nickel-Clad Steel	Lukens Steel Co., Coatesville, Pa.	Ni 99.4; C 0.1; Cu 0.1; Fe 0.15; Mn 0.2; Si 0.05	50	55-65	30	S, P, HR	A	C	B[19]	322
323	Olympic Bronze Type A	Chase Brass & Copper Co., Inc., Waterbury, Conn.	Si 3.0; Cu 96.0; Zn 1.0	20	60	60	S, P, R, W, T	A	A	A	323

No.	Material	Manufacturer	Nominal Chemical Composition (Per cent)	Yield Stgth.* 1,000 psi	Tensile Stgth.** 1,000 psi	Elongation % in 2 in.	Forms Available†	Welding Qualities‡‡			No.
								Arc	Gas	Resistance	
324	Olympic Bronze Type B	Chase Brass & Copper Co., Waterbury, Conn.	Si 1.5; Cu 97.5; Zn 1.0	15	40	50	R, W	A	A	A	324
325	Phosphor-Bronze "A"	Revere Copper & Brass, Inc., New York	P 0.2; Pb 0.05 max; Sn 5; Fe 0.05 max.; Cu 95	18-22	45-55	60-50	S, P, CR, B, W	B[22]	C	A	325
326	Phosphor-Bronze "A"	American Brass Co., Waterbury, Conn.	Cu 95; Sn 5	20	48	50	S, P, CR, B, T, W, R	A	C	B	326
327	Phosphor-Bronze "C"	American Brass Co., Waterbury, Conn.	Cu 92; Sn 8	24	60	65	S, P, CR, B, T, W, R	A	C	B	327
328	Phosphor-Bronze "D"	American Brass Co., Waterbury, Conn.	Cu 89.5; Sn 10.5	28	65	65	S, P, CR, B, T, W, R	A	C	B	328
329	Pure Clad 24S-O	Reynolds Metals Co., Louisville, Ky.	Reynolds 24S-O, high purity Al coating	33	56	18	S, P	D	B[23]	A	329
330	Pure Clad 24S-T	Reynolds Metals Co., Louisville, Ky.	Reynolds 24S-T, high purity Al coating	41	62	18	S, P	D	B[23]	A	330
331	Reynolds 2S-O	Reynolds Metals Co., Louisville, Ky.	Al 99.0 (min)	5	13	35	S, P, SH, B, W, R, T	D	A	A	331
332	Reynolds 2S½-H	Reynolds Metals Co., Louisville, Ky.	Al 99.0	14	17	9	S, P, W, T	D	A	A	332
333	Reynolds 2S-H	Reynolds Metals Co., Louisville, Ky.	Al 99.0	21	24	5	S, P	D	A	A	333
334	Reynolds 3S-O	Reynolds Metals Co., Louisville, Ky.	Mn 1.2; Al remainder	6	16	30	S, P, SH, B, W, R, T	D	A	A	334
335	Reynolds 3S½-H	Reynolds Metals Co., Louisville, Ky.	Mn 1.2; Al remainder	18	21	8	S, P, W, T	D	A	A	335
336	Reynolds 24S-O	Reynolds Metals Co., Louisville, Ky.	Cu 4.5; Mg 1.5; Mn 0.6; Al remainder	10	26	20	S, P, SH, B, W, T	D	B[23]	B[4]	336
337	Reynolds 24S-T	Reynolds Metals Co., Louisville, Ky.	Cu 4.5; Mg 1.5; Mn 0.6; Al remainder	45	68	19	S, P, SH, B, W, T	D	B[23]	B[4]	337
338	Reynolds 52S-O	Reynolds Metals Co., Louisville, Ky.	Mg 2.5; Cr 0.25; Al remainder	14	29	25	S, P, SH, B, W, T	D	A	A	338
339	Reynolds 52S¼-H	Reynolds Metals Co., Louisville, Ky.	Mg 2.5; Cr 0.25; Al remainder	26	34	12	S, P, W, T	D	A	A	339
340	Reynolds 52S½-H	Reynolds Metals Co., Louisville, Ky.	Mg 2.5; Cr 0.25; Al remainder	29	37	10	S, P, W, T	D	A	A	340
341	Reynolds R361-O	Reynolds Metals Co., Louisville, Ky.	Cu 0.25; Mg 1.0; Si 0.6; Cr 0.25; Al remainder	8	18	22	S, P, SH, B, W, R, T	D	A	A	341
342	Reynolds R361-W	Reynolds Metals Co., Louisville, Ky.	Cu 0.25; Mg 1.0; Si 0.6; Cr 0.25; Al remainder	21	35	22	S, P, SH, B, W, R, T	D	A	A	342
343	Reynolds R361-T	Reynolds Metals Co., Louisville, Ky.	Cu 0.25; Mg 1.0; Si 0.6; Cr 0.25; Al remainder	39	45	12	S, P, SH, B, W, R, T	D	A	A	343

*Yield strength is that load which will produce an elongation of .005″ in 1″. The value is obtained from stress-strain curves, and is based on a 25,000,000 psi Modulus of Elasticity for malleable iron, 6,500,000 psi for magnesium alloys, 10,300,000 psi for aluminum, 15,000,000 psi for brasses, 20,000,000 psi for 70/30 cupro-nickel.

**Single figure (50) indicates minimum value. Double figures (28-50) indicate range, which varies because of production processes or other causes; e.g., heat treatment, annealing, cold rolling, drawing, etc.

†Available forms: P=plates, S=sheets, SH=rolled or extruded shapes, CR=cold rolled, HR=hot rolled, B=bars, W=wire, T=tubing or pipe, R=rods, F=forgings.

‡‡Welding Qualities: A=Readily weldable. B=Weldable under favorable conditions (see footnotes). C=Not ordinarily weldable. D=No welding data available. E=Welding in experimental stage.

‡Also available from Chase Brass and Copper Co. and Revere Copper and Brass, Inc. Chase and Revere products may differ slightly in chemical compositions and/or tensile properties from those given here.

1. Carbon arc: play on zinc free filler rod of silicon or phosphor bronze types; 700-1000 F. preheat desirable for heavier gauges. 2. Slightly oxidizing flame desirable with filler rods or strips of base metal composition, or with "bronze" welding rods. 3. Accurate control over pressure, time and heat necessary. 4. Mild corrosion conditions only. 13. Weldable in a helium atmosphere. 15. Carbon arc: silicon bronze filler rods; flux necessary; arc length and manipulation of carbon electrode both important. 16. Slightly oxidizing flame recommended; flux necessary; "hot shortness" of alloys necessitates care to prevent cracking of "closed structure" type welds. 17. Surface must be free of silicon oxide; accurate control over variables necessary. 18. Preheating. 19. Limited to comparatively thin sections. 20. Applies to spot welding. Seam welding is also satisfactory but as yet in little commercial use. Butt welding is limited to comparatively simple shapes. 21. Comparatively short seams only. 22. Metallic arc: coated electrodes; preheat necessary in medium and heavy thicknesses. Carbon arc: phosphor bronze filler rods; arc length important—long arc preferred. 23. Must reheat treat.

★ CONSTRUCTION

All-Welded Sandwich Shop

By T. B. JEFFERSON

Stainless steel and aluminum combine to produce a glittering appearance in the metal-walled, metal-floored and metal-ceilinged hamburger stands fabricated by Valentine Industries, Inc. Welding makes it possible to build them.

Fig. 1—Valentine portable sandwich shops are fabricated and assembled at Wichita, Kansas, shipped as a unit to any point in the United States

RARELY does welding afford the opportunity for employment that has been made possible by Valentine Industries, Inc., Wichita, Kans., through its portable sandwich shop. These all-welded hamburger stands provide employment for weldors when they are being built and afterwards they give permanent jobs to from one to eight people, depending upon the number of cooks and waiters required to serve the customers.

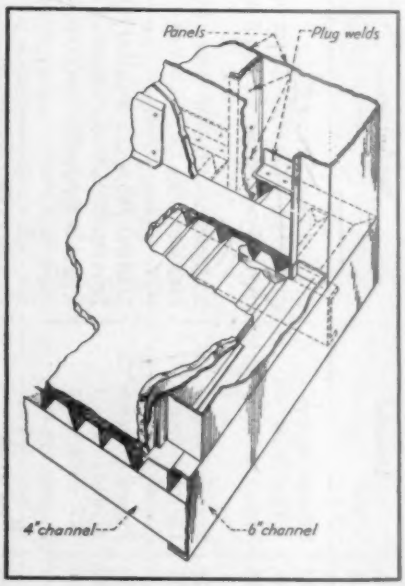
The men behind Valentine Industries started some years ago to design and market portable hamburger stands. When their previous marketing know-how was combined with the knowledge gained through close association with the arc welding and aircraft industries in Wichita, the result is the all-welded shop shown in Fig. 1.

The overall size of these structures is 10 by 24 feet, and they are shipped as complete units from Wichita to every part of the country by trailer or rail freight. The only construction work necessary at the site is to provide a foundation. The welded steel frame is sufficiently rigid to withstand the strains imposed upon it by travel.

The Valentine portable sandwich shop is fabricated in the plant of the H & H Parts Co., on the north side of Wichita. First, the channel members which form the sill or main base frame of the building are placed in a jig mounted on wheels. This jig makes it possible to move the base frame any place in the shop. Hence fabrication becomes essentially an assembly-line production process.

The main frame consists of 6-in. channels rigidly arc welded at the corners. To these are welded the 4-in. channels which serve as floor joists (Fig. 2). One of the 4-in. channels is placed at approximately

Fig. 2—Construction details of the sill or main base frame



every two feet across the 10-ft width of the building.

Side Walls and Roof

The next step is the mounting of the side walls, which are made from specially formed 20-gauge steel sheets. These sections are all alike and interlocking in design, as shown in Fig. 3. Each panel is plug welded to the adjoining panel at 6-in. intervals and is then welded to the top angle ring (a 2 by 3 in. angle) and the base channel assembly. The top angle ring stiffens the wall panels and provides a base for the roof panels. The latter are also 20-gauge steel sheets, similar in form to the wall panels.

The roof panels are welded together and welded securely to the 2-in. leg of the top angle ring. Their construction is detailed in Fig. 4. The ceiling panel flanges, which have a 4-in. drop in 9 ft. are filled with about 4 in. of metallic insulation. A ¾-in. lap insulation board is then laid across the roof panel flanges and fastened with screws. The laps in this insulation board are covered with 4-in. metal strips. Corrugated roofing is now laid on top of the insulation board, and flashing is provided at the front and back to allow water to run towards the back of the roof. Three drain spouts are provided on the back side.

The parapet is fastened to the wall panels (Fig. 4), and the insulation holes in the panels are covered with snap-on metal trim. The metal roofing is then faired into the parapet, and the entire roof is covered with tar.

The floor is also formed from 20-gauge sheet steel and so is very similar to the wall and roof panels. The metal flooring is welded to the channel floor joists and covered with approximately ½-in. of magnesite floor base. The sections of flooring expected to receive the most wear are additionally covered with ⅛-in. thickness of asbestos tile. The uncovered portion and the floor are subsequently painted with a floor enamel.

Window Frame Construction

The portable sandwich shop is now ready for the installation of electrical conduit and outlets. They are welded to the steel framework, which makes wiring an extremely easy operation. The window frames are also installed at this stage of construction.

Details of the window frame are shown in Fig. 5. It consists essentially of an inner and outer angle of sheet-steel stock, the inner frame angle being of stainless steel. The panels above and to each side of the window are reinforced with a 2 by 3 in. angle welded to the top ring and to the base frame. When the angles which form the frame have been welded and soldered into one unit, plate glass is installed with spring clips and calked. An extrusion is then screwed to the outside of the frame to hold the glass in place.

Aluminum Walls and Ceiling

With wiring and window frames completed, the interior of the building is ready for insulation and final finishing. The wall panels are covered with a ½-in. insulating layer of sheet rock. The insulation is fastened by drive screws to the panel frames of all four walls and is then covered with light-gauge aluminum sheeting. All four walls are now insulated with metallic fireproof insulation that is poured in through holes provided for this purpose.

The ceiling also is given an aluminum covering; this is made of special sections spot welded together into panels, each of which covers about a quarter of the ceiling. The panel units are fastened to one another by means of metal strips. The interior is now spray painted with a synthetic enamel and trimmed with snap-on stainless steel. Stainless steel is popular throughout this sandwich shop because of its lasting qualities and attractive appearance and because it is easily cleaned. Even the heavy-cored wooden door is covered with stainless steel.

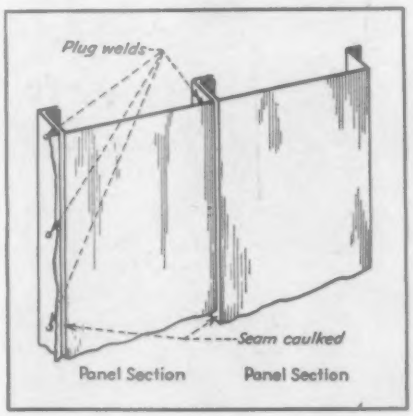


Fig. 3—Side panels are plug welded in interlocking fashion

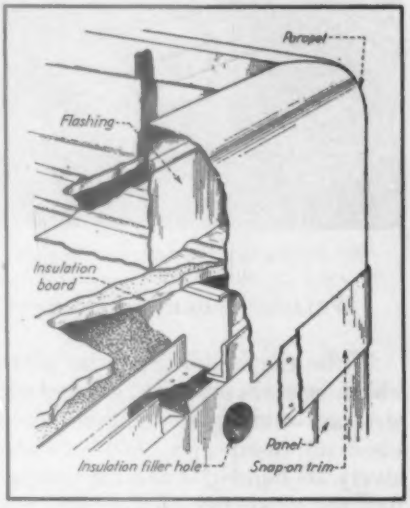


Fig. 4—Construction details of the roof panel and parapet

Fig. 5—Section showing how angles are put in to form window frame

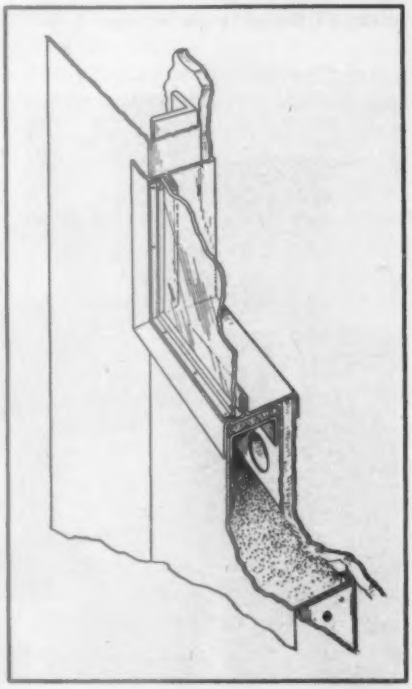


Fig. 6—The range (left) is also fabricated by flame-cutting and welding. Aircraft streamlining is incorporated in its design

Fig. 7—Another welded appliance is the 14-cu-ft mechanical refrigerator (extreme right)

Welded Cooking Range

While the building of the portable houses involves arc, gas and resistance welding, these three processes are used even more extensively to build the several unique fixtures of welded construction inside. The range (Fig. 6) is fabricated by flame-cutting and arc welding. As may be seen from the picture, the range has a fry griddle and a 4-pot dry-heat table, work and heating space on its top and cabinets above and below for storage. Here again stainless steel comes into play in the sheet-metal portions of the stove and the smoke hood, and aircraft design features are incorporated for appearance and sanitary considerations. The sheets are formed with a curved edge and rounded corners; this makes it possible to provide adequate stiffness to maintain the structure while eliminating all hard-to-clean overlapping joints and sharp corners.

The griddle is made of stainless-clad steel plate and is welded to the stove frame so as to eliminate grease leaks. This clad plate provides a stainless surface for cooking backed up with a heavy mild-steel plate to withstand the heat of a continuous fire.

Another feature which contributes to the ease of maintaining a sanitary condition is found in the sliding doors of the stove. These may be readily removed for cleaning purposes—a feature used on all storage cabinets.

Refrigerator, Floor Cooler

Two other fixtures of considerable importance are the 14-cu-ft mechanical refrigerator (Fig. 7), and the floor cooler directly behind it. Both of these appliances are fabricated by welding stainless-steel sheets. As in so many operations in the construction of these portable sandwich shops, arc, oxy-acetylene and resistance welding are all used. In some instances spot welding serves only as a means of tacking parts together for subsequent arc or gas welding operations; in other instances it is the only welding process employed.

With its fixtures in place, the shop is now ready for the finishing touches (Fig. 8). These include the placing of the counter and stools, the erection of miscellaneous shelves and the hanging of mirrors. All of these details are taken care of before the shop is transported to its final location.

Fig. 8—Counter and stools are installed and even the mirrors are hung before shipment

Testing Big Girders for Ships

THE STRENGTH of large welded steel structures, brought into prominence during the war by the few failures of Liberty ships that occurred, is being investigated by the Structural Steel Committee of the Welding Research Council in coöperation with the Engineering Mechanics Laboratory of the National Bureau of Standards. Tests already concluded indicate that factors of design as well as welding have an effect on the initial formation of a crack. The continuation of a crack depends upon the notch sensitivity of the steel, a property overlooked in past specifications for ship plate.

This 9-ton, 22-ft welded girder of fully killed structural steel is shown sustaining a load of 1,685,000 lb. The center deflection reached 18.06 in., permanent center deflection after removal of load was 16.45 in.

Build Stressed Girders

The tests were carried out on six 9-ton welded structural carbon-steel box-girders of 22-ft span constructed at the Ingalls shipyard, Pascagoula, Miss. Each girder has an overall width of 2 ft 6 in. and a depth of 2 ft 1½ in. Very abusive welding procedures and sequences were used, along with some unfavorable details of design, for the deliberate purpose of producing the highest possible residual stresses. Especially was this so in the vicinity of the transverse closing butt of the tension flange, which was welded last under extreme conditions of restraint. The tension flange plate is fitted between the side web plates to simulate the joints between the deck of a ship and the side plating when the ship is subjected to "hogging" stresses (with an elastic curvature that is convex upwards).

Two Girders Failed

The girders were successfully proportioned to insure against failure by lateral deflection and buckling or twisting, the manner in which test beams and girders usually fail. The compression flange was made 2½ in. thick.

The first girder, constructed of ordinary semikilled structural steel hull plating taken from stock in the shipyard, was load tested at room temperature. It failed by rupture with a brittle or "cleavage" fracture and a sudden release of energy that shook the building. Failure did not occur until the measured strains and elastic deflection had indicated extreme fibre stresses approximately equal to the conventionally determined ultimate tensile strength of the material, not far below the modulus of rupture of 75,600 psi as computed for the breaking load of 1,397,000 lb and corresponding bending movement of 71,200,000 lb-in. Total deflection at failure was some 8 in., about 7 of which were permanent set and less than 1 in. elastic deflection.

The second girder was of fully killed steel and tested at about −45 F. It failed in a fracture that was more of a compound, shattering type under the influence of cold temperature, and the entire girder snapped in two. The breaking load of 1,165,000 lb was only 16.5% lower than that for the first girder.

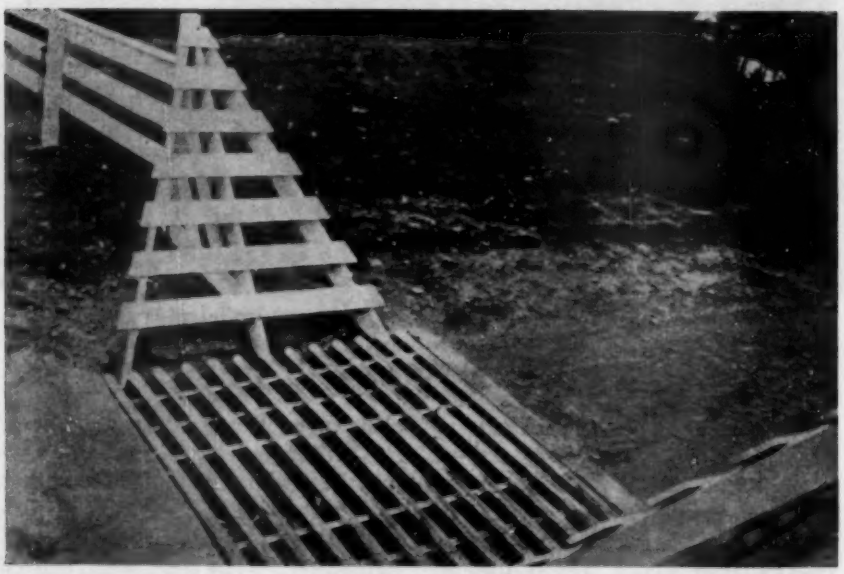
One Girder Survived

The third girder, also of fully killed steel, did not fail under a load of 1,685,000 lb (see picture). This load was equally distributed between two load points 2½ ft on either side of the mid-span. When the center deflection reached 18.06 in., the girder was almost touching the supporting girders of the test apparatus, and further loading was impossible. The permanent center deflection after removal of the load was 16.45 in. The extreme fibre stresses, computed under this loading, were 91,200 psi in the projections of the side plates and 70,200 psi in the tension flange plate. It is probable that 70,200 psi was actually realized. The extensive strain gauge readings still remain to be analyzed.

The purpose of the research program is to investigate, at various significant temperatures: (1) the effect of severe geometrical constraint against ductile behavior and upon the capacity of a welded structural member for resisting rupture under external load and (2) the detrimental effects of residual stresses.

The character of future tests has not been decided. The testing of girders preheated during welding, testing at various intermediate temperatures and studies of the effects of normalizing heat treatments subsequent to construction of the girders are all contemplated. Out of these tests is expected to come a fuller knowledge of the behavior of large welded steel structures.

On the Job



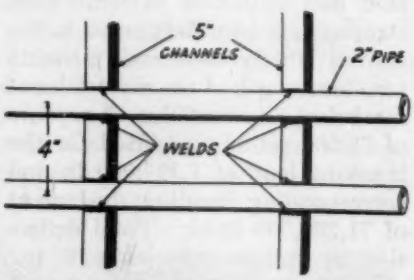
Courtesy The Lincoln Electric Co

Six 5-in. channels, 13 lengths of 2-in. pipe are welded together to make this cattle "gate"

Gateless Cattle Gate

CATTLE will not cross the "gate" illustrated in the accompanying picture, although it offers no bar to the passage of vehicles and pedestrians. To make it, dig a hole approximately 8 ft wide by 6 ft across and reinforce all sides at the top by pouring concrete slabs about 4 in. square. Embed in the concrete the ends of six 5-in. channels to serve as cross supports.

Thirteen pieces of 2-in. pipe are now cut to the proper length and laid across the channels as shown. The pipes are spaced 4 in. apart (center to center distance). At each intersection, welds are made on two sides of the pipe to join it to the channel (see sketch).



Sketch showing spacing and weld location

* *

Mightier than the Bull

Two registered bulls with a gross weight totaling 4,600 lb were continually breaking down the frame fence belonging to their proud owner. It had to be stopped, so Ritenour's Welding Shop, Midland, Mich, was called upon to build a permanent bull pen.

Fences of welded steel piping proved to be mightier than the bull. Seven hundred feet of 6-in. pipe and 1,500 feet of 3-in. pipe were used to form two lane pens 100 ft long that included several feeding stalls.

The 6-in. pipe was flame-cut to lengths and set in concrete to make the upright posts. Four pieces of 3-in. pipe were then flame-cut to size and welded to each post. Finally, lengths of 3-in. pipe were inserted vertically between the horizontal cross pieces and welded into position about halfway between the 6-in. uprights. The bulls gave up.

The portable gasoline-engine-driven welder used for this job consists of a 300-amp generator powered by an Oldsmobile engine. The welding was done with $\frac{5}{32}$ and $\frac{3}{16}$ in. all-position mild-steel electrodes, of a type designed especially for poor fit-up conditions.

* *

Aligning Big Pipes

THE alignment of pipe sections on the order of diameter shown in the accompanying picture requires force of no mean magnitude. Here the members are being held together for welding by a push-and-pull unit of 10 tons capacity—a widely used tool for such giants' tasks. The big pipes are a part of the 41-mile Salt Lake aqueduct line and will be laid under the Provo river, Utah.

Courtesy, The Howard Bros. Co.

Two permanent bull pens 100 ft long were fabricated from 6-in. and 3-in. steel piping

Courtesy Templeton, Kenley & Co

Arc welding on a high-head steel section of the 41-mile Salt Lake aqueduct pipe line

DEPRESSION IN '47?

...controls can bring one

IT IS CONVENTIONAL for the American business man, who values freedom, to protest against government regulation. On this account, many people who do not know the facts in detail are inclined to discount current business protests against the post-war application of wartime economic controls. This is particularly true since in his report for the third quarter of this year, the Director of War Mobilization and Reconversion implied that business is in fine health by remarking that "business profits, after taxes, are at the highest point in history."

In complaining about government controls, however, the American business man is not crying wolf. These controls were an essential war weapon. Now, however, they are contributing decidedly to a twisting and distorting of the American economy in a degree which, if not soon corrected, may well start production and employment down the toboggan.

One general indication of how badly twisted our economic system has become is found in the wide disparities in the amounts by which different groups of prices have increased. Since 1941, for example, farm prices have advanced an average of about 125%. Industrial prices, more tightly controlled than any other group except rents, have increased only about 32%. Meanwhile, straight time hourly earnings of industrial workers have gone up about 60% and the cost of living about 43%.

The advances of individual prices within these groups have also varied enormously. Among industrial prices, that of finished steel has gone up only about 14% since 1941, while lumber has gone up over 50%. Hourly wage rates in the women's garment industry have gone up 116%, while those in the brewing industry have gone up only 33%. That share of the cost of living due to rent has gone up only 4%, while that due to the cost of clothing has gone up over 60%.

Well, What Of It?

At least four things of major importance:

1. Production, under the influence of price control, has been heavily concentrated in some lines to the neglect of others. Result—unbalanced production, unbalanced inventories, and a serious cut in the flow of goods to consumers.

2. More or less uniform post V-J Day wage increases, promoted by the federal government, have imposed a far more serious cost problem on some industries than on others. This is particularly true of some of the most basic industries.

3. While, as a whole, "business profits, after taxes, are at the highest point in history" (due in part to a temporary excess profit tax rebate arrangement) there are enormous disparities in the profits of different industries. Some key industries are making little or no profits.

4. If not corrected, the distortion of prices, wages and production, which has resulted in such a wide disparity of profits, can contribute decisively to a major business upset.

The most striking example of the distortion of production by controls was, of course, that provided by a metropolitan meat famine at a time when beef cattle crowded the ranges. This has now been recognized. But there are many other distortions. Abundance of sports clothes, acute shortage of more essential clothing made from the same kind of cloth. Successive shortages of critically important products like baling wire and nails as the price lid on steel is jiggled first this direction and then that.

Some of these distortions of production are due to material shortages. But a major contributor is uneven application of controls, and the total removal of some while others are held firm. Among the results are bulging inventories of partially completed assemblies and shut-downs while waiting for parts.

Wage Complications

While price controls, unevenly applied, have shunted production first this way and then that, the federal government has further complicated the situation by promoting uniform wage rate increases without regard to varying capacities to pay them. The greatest single contribution to this distortion was made by the President himself. In the course of

unsuccessfully trying to mediate the dispute over steel wages last January he recommended a wage rate increase of 18½ cents an hour. Immediately that increase was accepted by organized labor as par for the first round of wage adjustments, having the sanction of the White House itself. The game then became to beat par.

But the capacity of different industries to pay wage increases varied greatly. During the war some had hiked their pay much more than others. Moreover, in some industries wages are a much larger element of total cost than in others. In 1939 (last year for which figures are available) wages ranged all the way from 2½% of total sales in cigarette manufacturing to 34.3% in hosiery manufacturing and 65.2% (for wages and salaries combined) in soft coal mining.

Under these circumstances, some industries were far less able to meet a uniform wage increase than others. Nonetheless, many of them had uniform wage increases imposed upon them. Then the price lid was held firm. This, coupled with material shortages and production difficulties which also choked output, squeezed the profit right out of those industries.

A Study In Contrasts

Some of the most important industries are making little or no profits while they bump along on a production volume which fails to meet consumer needs and prevents attainment of maximum efficiency. The automobile industry affords one conspicuous example. Another is electrical manufacturing, and rail equipment is yet a third. All of them are crucially important. Many other lines of business, of course, are extremely profitable. For example, the profits of a group of large retail stores were 150% higher during the first half of this year than they were a year ago; the profits of a group of motion picture companies were up 140%.

In the meantime, the workers in some of those low-profit industries are in no bed of roses. The increase in the cost of living since 1941 is now outstripping the increase in the hourly wage rate of workers in a number of industries, where wage rates have not risen as much as the average. On a weekly basis, a shorter work week, with less overtime, has combined with the recent upsurge in consumer prices, to place the living standards of some of these workers below the wartime level.

Such circumstances obviously create pressure in the ranks of these workers for another round of wage increases. But as long as the profit remains squeezed out of their industries wage increases, if any, must be translated either into higher prices, or, if the government sits tight on the price lid, into losses which will discourage production and ultimately cost workers their jobs.

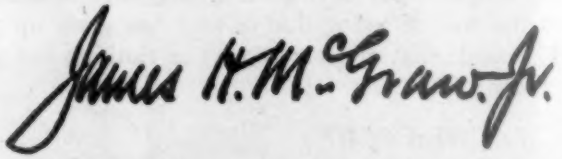
What To Do?

Salvation both for the workers and for employers in the relatively profitless section, a peculiarly important group of industries, must be looked for primarily by increasing productivity, thereby decreasing the cost per unit. Part of this higher productivity can come only from individual efforts of the workers themselves. Another part can come from an elimination of bottlenecks in materials and parts which prevent the labor force from working most efficiently. Only by greater output per man-hour can workers and management solve their common problem.

Until productivity has been thus increased, it is hard to think how the federal government could do a greater disservice both to labor and to industry than to repeat its performance of promoting a uniform national wage increase. With the present distortion of the national economy, some industries might again take such an advance in their stride. With many others it would raise even greater havoc.

While avoiding like the plague promotion of another uniform wage adjustment, the federal government must make it a primary objective to relieve distortions caused by the uneven application of other controls, primarily price control. Nature has given a lift to the elimination of distortions by providing bumper grain crops which should in time reduce that staggering disparity between a 125% increase in farm prices and a 32% increase in industrial prices. But that process must be speeded as a matter of conscious policy. No element of such a policy is more important than expediting the decontrol of industrial prices. Such a course is clearly essential to achieve that balance in the production of materials and parts required for maximum output.

Business and labor both want a sustained prosperity in which all will share. Sustained prosperity can be achieved only if we eliminate the distortions in wages, prices and profits which now restrain so much vital production.



President McGraw-Hill Publishing Company, Inc.

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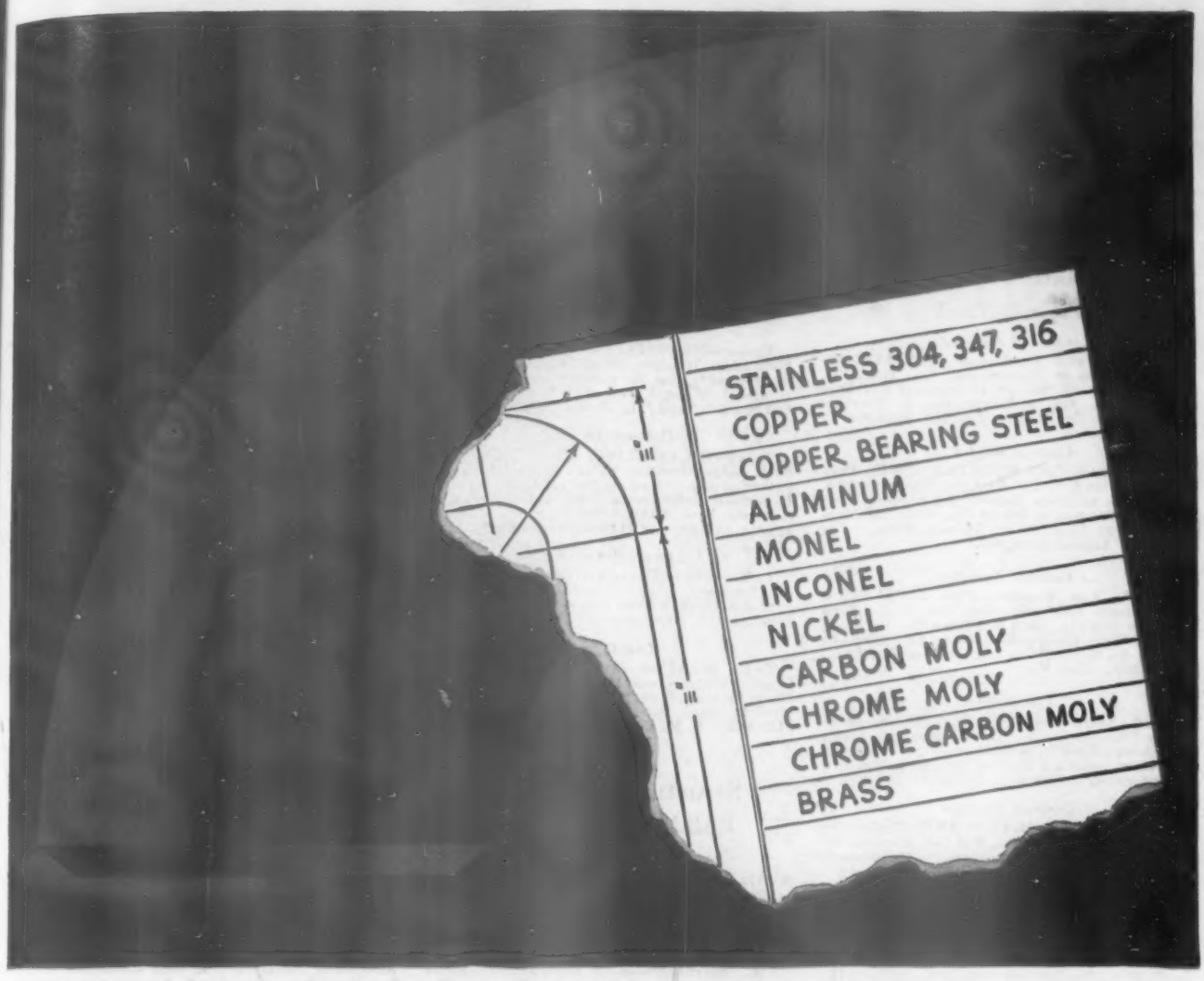

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Contract warded

★ **California**—GAS PIPELINE—Pacific Public Service Co., 200 Bust St., San Francisco, 395 mi 6- to 12-in natural gas pipeline from Pittsburg to point in Solano Co., to Pacific Pipeline Constr. Co., 122 S. Victory Bldg., Los Angeles. Approx. $900,000.

Contract Awarded

★ **Calif., Los Angeles**—GAS PIPELINE—Southern California Gas Co. & Southern Counties Gas Co., 8010 S. Flower St., installing 214 mi. 30 in. gas pipeline, Santa Fe Springs to Blythe, to H. C Price Co., Bartlesville, Okla. $3,750,000. Bids 9/9.

Low Bidders

Calif., Sacramento—FORCE MAIN—Sanitation Dist. 1, c/o E. A. Fairbairn, co. engr., Courthouse, Sept. 30, welded steel force main and river levee crossing 2 mi. from here, from McGuire & Hester Co., 796 66 Ave., Oakland. $64,964.

Contract Awarded

★ **Ill./Tuscola**—OIL PIPELINE—Panhandle Eastern Pipe Line Co., Box 148, Stinnett, 26 mi. 26 in. loop crude oil pipeline, to Midwestern Constr., Sunray Tex. Approx. $1,100,000.

Contract Awarded

Ia., Bedford—TANK—Town, Bd. Water Works Trustees, H. E. Nelson, secy. and city clk., 200,000 gal. double elipsoidal steel tank on tower, etc., to Pittsburgh-Des Moines Steel Co., 1015 Tuttle Ave., Des Moines. $24,000. Bids 8/30.

Low Bidders

Md., Hyattsville—RESERVOIR—Washington Suburban Sanitary Comn., Hamilton St., Sept. 6, welded steel reservoir for storing water, Contr. 262-W, from Chicago Bridge & Iron Co., 930 F St. N. W., Wash., D. C. $243,600.

Contract Awarded

★ **Mich., Saginaw**—PIPE—Saginaw-Midland Water Dist., Saginaw, water supply line from Saginaw Bay to supply water sys., incl. submerged crib in 50 ft. water, 10,000 66 in. steel intake pipe, 81 mi. prestressed rein.-con mains comprising 48 mi. 48 in., 30 mi. 36 in. and 3 mi. 24 in. pipe, two 70 m.g. pump. stations, prestressed rein.-con. pipe for entire line to Lock Joint Pipe Co., Ampere, N. J. and Price Bros. Co., 1932 E. Monument St., Dayton, O., $5,203,326***pipe laying to Lock Joint Pipe Co., Ampere, $813,600***to Charles F. Smith & Sons, Inc., 118 Spirea Dr., Dayton, O., $349,180***submerged crib and intake, to Great Lakes Dredge & Dock Co., 112 S. Michigan Ave., Chicago, Ill., $1,243,200***2 pump. stations awarded on basis of combined bid for both, to Bass Engineering & Constr. Co., 215 Birmingham Theatre Bldg., Birmingham, $798,-800***pump. equipment, electrical driven, to De Laval Steam Turbine Co., Broad St. Sta., Phila., Pa. $123,000. Grand total $9,031,106.

Contract Awarded

Minn., Blue Earth—TANK—City, Bd. P. Wks., J. J. Kehr, secy., furnishing, erecting 250,-000 gal. elevated steel water tank, to Pittsburgh-Des Moines Steel Co., 1015 Tuttle St., Des Moines, Ia. $38,000. Bids 8/22.

Contract Awarded

Mo., St. Louis—GAS STORAGE TANKS—Laclede Gas Light Co., 1017 Olive St., Zone 1. 4 steel propane gas storage tanks, 151 Rutger St., 3 at 322 Catalan St., own forces. $55,000.

Contract Awarded

Oklahoma—GAS PIPELINE—Cities Service Co., First National Bldg., Oklahoma City, 62 mi. 12 in. gas pipeline from Edmond to the Drumwright Oklahoma compressor station, to Ray Smith Constr. Co., El Dorado, Kan. Est. $900,000. Bids about 8/1, awarded 8/6.

Contract Awarded

Oklahoma—OIL PIPELINE—Magnolia Pipe Line Co., Magnolia Bldg., Dallas, Tex., taking up and reclaiming 40 mi. 8 in. crude oil pipeline between Maud and Stonewall, to B shop & Lock Constr. Co., Magnolia Bldg., Dallas, Tex. Approx. $48,000.

Contrae Awarded

Texas—OIL PIPELINE—Shell Pipeline Corp., Shell Bldg., Houston, 58 mi. 10 in. crude oil pipeline reconditioning (on main between Kilgore and Houston), Houston area, to Holland Constr. Co., Old Spanish Trail Rd., Houston. $386,000.

Contract Awarded

Texas—OIL PIPELINE—Shell Pipeline Corp., Shell Bldg., Houston, 21 mi. crude oil pipeline gathering sys., 32 mi. crude oil trunk pipelines (Kilgore-Houston main line), Kilgore area, to Anderson Bros., Old Spanish Trail Rd., Houston, approx. $94,000 and $146,000 respectively.

Contract Awarded

Texas—PIPELINE—Atlantic Pipe Line Co., M. Esperson Bldg., Houston, connecting oil products pipeline from refinery to Port Neches, Jefferson Co., force account. Approx. $40,000.

Low Bidders

Tex., McAllen—PIPELINE—Hidalgo County Water Control & Imprvt. Dist. 15, C. Breeding, mgr., Sept. 11, approx. 48 mi. irrigation pipeline, from Reising Const. Co., Edinburg. $489,646. F. M. Card, McAllen, engr.

Structural & Piping—Buildings—All Types

Contract Awarded

★ **Ala., Auburn**—DORMITORY—Alabama Polytechnic Institute, dormitory, Contr. 2, to Daniel Constr. Co., 824 7 Ave. S., Birmingham. Approx. $800,000. H. L. Holman, Ozark, archts.

Contract Awarded

Ala., Birmingham—WAREHOUSE—Kraft Food Co., 500 W. Peshtigo St., Chicago, Ill., concrete, steel food storage warehouse, to Del. E. Webb Constr. Co., 75 E. Wacker Dr. Chicago, Ill. Est. $200,000. Olsen & Urbain, 75 E. Wacker St., Chicago, Ill. archts.

Low Bidders

Ala., Mobile—SCHOOL—Mobile Co. Bd. Educ., Plateau School, from Bernard & Byrd. 271½ N. Royal St. $214,000. F. Clarke, Merchants Bank Bldg., archt.

Contract Awarded

★ **Ala., Tuscaloosa**—DORMITORIES—University of Alabama, general contract 3 girls dormitories, on Denny Field, to D. T. Underwood, Martin Bldg., Birmingham, $857,000; general contract 3 boys dormitories in Ridgecrest Area, to Batson-Cook Co., West Point, Ga. $683,900.

Ariz., Phoenix—PLANT—Arizona Publishing Co, Heard Bldg, 1 story, concrete, steel newspaper publishing plant and office, to Del E. Webb Constr. Co., P.O. Box 4066. Est. $700,-000. Awarded 9/10.

Contract Awarded

Ark., El Dorado—PLANT UNITS—Lion Oil Co., El Dorado, three 45 day ammounia-oxidation units for production of nitric acid. Owner builds. Approx. $750,000.

Contract Awarded

Calif., Fresno—WAREHOUSE—Fresno Warehouse Co., State Hy, rebuilding fire destroyed warehouse, to J T. Cowan, 546 Brix Bldg. Est. $100,000-$150,000.

Contract Awarded

Calif., Huntington Lake—MACHINE SHOP—Southern Calif. Edison Co., 601 W. 5 St., Los Angeles, 62x89 ft., steel, rein.-con. machine shop addn., craneway, etc., Big Creek Plant 6, near here, to Robert E. McKee, 4700 San Fernando Rd., Los Angeles. Approx. $150,000.

Low Bidders

Calif., Laguna Beach—TREATMENT PLANT—City, City Hall, Sept. 1, sanitary sewerage sys. Cliff Dr. and other streets, outfall, exten. treatment plant, Sanitary Lateral Sewer Dist. 4, McKnight addn., from Charles J. Derfman, 124 N. LaBrea Ave., Los Angeles. $416,-974. CD 729—ENR 8/1.

Contract Awarded

Calif., Los Angeles—FACTORY—Apex Steel Corp., Ltd., 6111 S. Eastern Ave, 118x260 ft. factory, 70x125 ft., steel office, own forces. $94,000. A. C. Martin & Assoc, 333 S. Beaudry Ave., archt.

Contract Awarded

Calif., Los Angeles—FACTORY—Bauman Furniture Mfg. Co., 6236 S. St. Andrews Pl., 48x164 ft. and 62x123 ft., steel, concrete, brick factory addn., alterations, own forces. $100,-000. A. C. Leatherwood, 2454 Kenilworth St., engr.

Contract Awarded

Calif., Los Angeles—WAREHOUSE—Kraft Foods Co., 500 Peshtigo St., Chicago, Ill., rein.-con. warehouse, steel frame and roof decking at Eastern and Slauson Ave., to Del E. Webb Constr. Co., 5101 San Fernando Rd. Approx. $340,000. A. C. Martin & Associates, 333 S. Beaudry Ave., archt.

Contract Awarded

Calif., Los Angeles—Warehouse, etc.—Southern Counties Gas Co., 810 S. Flower St., 90x200 ft. rein.-con. administration bldg., steel frame warehouse, processing plant for coating steel pipe, small storeroom, etc., to R. J. Daum Const. Co., 6803 W. Blvd., Inglewood. Approx. $475,000.

Contract Awarded

★ **Calif., San Bruno**—HANGARS, etc.—United Air Lines, Post and Powell Sts., San Francisco, steel, rein.-con. B-29 hangars, etc. and rein.-con. steel, maintenance base, over-haul base, flight research center, shops, offices, etc., to Austin Co., 618 Grand Ave., Oakland. $600,000 and $1,750,000, respectively.

Contract Awarded

Calif., Sausalito—PIERS—Sausalito Shipbuilding Co., R. Rich, genl. mgr., 1702 Bridgeway, 6 piers providing berthing facilities, for fishing fleet, marine restaurant, admin. bldg., etc., own forces; dredging 300,000 cu. yd., to Associated Dredging Co., 465 California St., San Francisco. Planning & Engrg. Assn., 1161 Market St., San Francisco, archts.

Low Bidders

★ †**Colo., Denver**—BLDG. REMODELING—Public Bldgs. Admin., 18 and F Sts., N. W., Wash., 25, D. C., Sept. 27, remodeling 6 bldgs., at Federal Center for Bureau Reclamation. from Mead & Mount Constr. Co., 422 Denver Natl. Bldg., Denver. $835,000.

Low Bidders

★ †**Colo., Grand Junction**—HOSPITAL, etc.—U. S. Eng., 1 and Douglas Sts. N.W., Wash. 25, D. C., Oct 3, six story graduated down to three story, 36x391 ft. concrete main hospital bldg., also managers, nurses and attendants quarters, apartment, storehouse, station garage, boiler house, utility shop, laundry, incinerator bldgs., air conditioned and power plant, for Veterans Admin., Vermont Ave. between H and I Sts. N. W., Wash. 25, D. C., from Olson Constr. Co, 250 E. 1 St, Salt Lake City, Utah. $3,-463,269.

Contract Awarded

Conn., Meriden—BUSINESS BLDG.—Derecktor Holding Corp., 9 W. Main St., 4 story, brick, steel business bldg. Owner builds. $225,-000. B. H. Winston, 465 Lexington Ave, New York, N Y., archt.

★ †**Conn., Waterbury**—FOUNDRY—Scoville Mgr. Co., 99 Mill St., brick, concrete, steel foundry, to Stone & Webster Corp., 49 Federal St., Boston, Mass $638,000. H. L. Thompson, 99 Mill St., archt.

Contract Awarded

D. C., Wash.—SCHOOL—District Comrs., District Bldg., Richardson School, 53 and Blaine Sts. N. W., to J. D. Hedin Constr. Co., 820 Michigan Ave. N.E. $502,220. Bids 9/6, awarded 9/18.

Contract Awarded

★ **D. C., Wash.**—ADMINISTRATION BLDG.—Pan American Union, 17 St. and Constitution Ave. N.W., administration bldg., to Turner Constr. Co., 1500 Walnut St., Phila., Pa. $1,000,000. Awarded 9/27 A. Kelsey, Quogue, N. Y., assoc. archt.

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Contract Awarded

Fla., Jacksonville—PLANT—Wilson & Toomer Fertilizer Co., Talleyrand Ave., concrete, steel sulphuric acid mfg. plant, to George D. Auchter Co., foot of E. 56 St. Est. $300,000.

Contract Awarded

Fla., Miami—PLANT—Bordens Dairy, 7103 NE 2 Ave., dairy plant, to Paul Smith Constr. Co., 3301 N. Miami Ave. $187,400. Cowell & Robinson, Miami, archts.

Contract Awarded

Fla., Miami—PLANT—Florida Power & Light Co., Ingraham Bldg., generator plant addn., to Ebasco Services, Inc., 2 Rector St., New York, N. Y. Est. $530,000.

Contract Awarded

★ **Ga., Savahnah**—City, c/o Water Comm., water supply sys., heating, to Poe Pipe & Heating Co., $31,783***filtration plant, to Virginia Engrg. Co., Norfolk, Va., approx. $2,110,000***raw water lines and distr. line to Gair, Inc., to Jones Constr. Co. and Diamond Constr. Co., 44 E Bay St., $446,000. Grand total $2,587,783.

Contract Awarded

★ **Ill., Alton**—FLOUR MILL—Russell-Miller Milling Co., J. R. Mulroy, mgr., Alton, 9 story, 141 ft. high flour mill, to J. J. Wuellner & Sons Constr. Co., Oak and Front Sts., Alton. Est. $2,000,000. CD 7/31—ENR 8/22.

Contract Awarded

Ill., Arlington Heights—SCHOOL—School Dist. 314, Arlington Heights, 2 story, brick, concrete, steel high school addn., to Axel E. Johnson, 4041 N. Kilbourn St., Chicago***plumbing, to Fottes, Love & Sieben, 4105 N. Damen St., Chicago***electrical work to Wadeford Electric Co., 205 W. Wacker Dr., Chicago***heating, to Northwestern Heating & Plumbing Co., 1905 Greenleaf St. Evanston. Est. $250,000. Childs & Smith, 430 N. Michigan St., Chicago, archts.

Contract Awarded

★ **Ill., Chicago**—HOSPITAL ADDN.—Chicago Community Hospital, 2320 E. 93 St., general contr., 5 story, brick, concrete, steel hospital addn., to Paul Schwendener, 7553 S. Chicago St.***plumbing, to Charles Thumm Co., 4435 N. Damen St.***heating, to Windsor Heating Co., 8723 Commercial Ave.***electrical work, to A. C. Skon Co., 670 N. Carpenter St. Est. $600,000. H. Frenzel, 127 N. Dearborn St., Chicago, archt.

Contract Awarded

Ill., Chicago—WAREHOUSE—Leishen-Sobel Steel Co., 4914 Wentworth St., 1 story, 60x200 ft., brick, concrete, steel warehouse, to Poirot Constr. Co., 2001 W. Pershing Rd. Est. $200,000.

Contract Awarded

★ **Ill., Chicago**—MILLINERY CENTER—Owner, c/o Harmon L. Waterstone, 65 E. South Water St., remodeling 12 story and constructing 7 story, 30x100 ft millinery center bldg. addn., to James McHugh Constr Co., 6449 S. Park St.***plumbing and heating to Economy Plumbing & Heating Co., 1308 S. Pulaski St.*** electrical work, to Continental Electric Constr. Co., 3540 N. Southport St. Est. $750,000.

Soon Lets Contract

Ill., Chicago—WAREHOUSE-GARAGE—United Motor Service Div. of General Motors, General Motors Bldg., Detroit, Mich., soon lets contract 1 story, 245x327 ft., brick, concrete, steel warehouse and garage.

Contract Awarded

★ **Ill., Chicago**—FACTORY, etc.—Velsicol Corp., 120 E. Pearson St., general contract 3 story, 86x194 ft., brick, steel, concrete factory and laboratory, to C. Rasmussen Corp., 1443 W. Adams St.***plumbing, to M. Weil & Son, 209 E. Superior St.***electrical work, to Marsh Electric Co., 1448 W. Adams St. Est. $300,000.

Contract Awarded

★ **Ill., Lincoln**—FACTORY—Lehn & Fink Products Corp., 683 5 Ave., New York, N. Y., general contract 1 and 2 story, 425x500 ft., concrete, steel factory, 60x178 ft. offices, 60x75 ft. tank bldg., to B.W. Constr. Co., 307 N. Michigan Ave., Chicago***structural steel, to Blaw Knox Co., 122 S Michigan Ave., Chicago*** glass, to Pittsburgh Plate Glass Co., 451 N. St. Clair, Chicago. Est. $1,800,000.

Contract Awarded

★ **Me., Orono**—DORMITORIES—University of Maine, A. A Hauck, pres., 3 brick, steel, concrete dormitories, on college campus, to F. W. Cunningham & Co., 181 State St., Bangor. Est. $2,000,000. Crowell & Lancaster, 6 State St., Bangor, archts.

Contract Awarded

★ **Md., Baltimore**—TELEPHONE EXCHANGE—C. & P. Telephone Co., St. Paul and Pleasant Sts., 6 story, bsmnt., 90x140 ft., Wolfe dial exchange bldg., to Consolidated Eng. Co., 20 E. Franklin St. Over $950,000. Taylor & Fisher, 1012 N. Calvert St., archts.

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G-E RESISTANCE WELDING CONTROL

GENERAL ELECTRIC

Contract Awarded

★ **Md., College Park**—DORMITORIES—University of Maryland, College Park, 3 men's dormitories, agriculture bldg. and dining hall addn., to Burnap-Owens Constr. Co., College Park. Est. $1,590,000.

Contract Awarded

★ **Md., Sparrows Point**—WAREHOUSE—Bethlehem Steel Co., 3 St., Bethlehem, Pa., warehouse, assorting facilities for electrolytic tin plate, separate contracts $662,000.

Contract Awarded

★ **Massachusetts**—TREATMENT PLANT—Commonwealth of Mass., 20 Somerset St., Boston, Nut Island sewerage treatment plant, to V. Barletta Co., 10 Whipple Ave., Roslindale, $1,179,736.

Contract Awarded

★ †**Mass., Boston**—HOUSING—Pub. Housing Auth., NHA, 24 School St., Boston, 972 housing units, to John Bowen Co., 129 Newburg St. $6,977,000.

Contract Awarded

Mass., Willimansett—FACTORY—C. L. Church Mfg. Co., Montgomery St., 2 story, bsmnt., brick, steel, concrete factory, to Ernest F. Carlson Co., 1694 Main St., Springfield. Est. $300,000.

Contract Awarded

★ **Mich., Bay City**—HOSPITAL—Sisters of Mercy, Bay City, brick, steel, concrete hospital addn., to Walter Butler Co., 1218 Maccabees Bldg., Detroit. Est. $500,000. Charles J. Sullivan, 2631 Woodward Ave., Detroit, archt.

Soon Lets Contract

Mich., Detroit—PLANT—Chevrolet Forge Div. of General Motors Corp., 3044 W. Grand Blvd., Zone 2, soon lets contract brick, steel, concrete bumper plant addn. Approx. $100,000. Albert Kahn Associated Architects & Engineers, Inc., 345 New Center Bldg., Zone 2, archt.

Low Bidders

Mich., Grand Rapids—DOMICILIARY—Michigan Veterans Facility, Grand Rapids, brick, steel, concrete, stone domiciliary, from Strom Constr. Co. 625 1NW. $460,000.

Contract Awarded

★ **Mich., Wyandotte**—CHEMICAL PLANT—Wyandotte Chemicals Co., Biddle Ave., 11 brick, steel, concrete, chemical bldgs., etc. for plant expansion, to Cunningham Rudy Co., 3087 W. Grand Blvd., Detroit. Est. $25,000,000.

Contract Awarded

Minn., Minneapolis—OFFICE—Chamber of Commerce, A. M. Howard, chn. Building Com., 4 St. and 4 Ave. S., general contract remodeling main office bldg. at 4 St. and 4 Ave. S. and altering adjoining office on 3 St., to C. F. Haglin & Sons, 720 National Bldg., $285,000. E. J. Prondzinski, 949 Plymouth Bldg., archt.

Contract Awarded

Minn., Minneapolis—FACTORY—Standard Iron & Wire Works, H. H. Z. Demeules, 1900 Northeast 3 St., general contract 1 story, part bsmnt., 100x200 ft. steel, concrete block curtain-wall factory, 30 Ave. and North and 2 Sts., to G. F. Cook Constr Co., 2608 Nicollet Ave. Est. about $120,000. Bids 9/6. CD 8/27.

Contract Awarded

Minn., Rochester—HOSPITAL—Kahler Corp., R. Watson, pres. and genl. mgr., general contract 6 story, brick concrete, wing addn. Colonial Hospital, to G. Schwartz & Co., Rochester. Est. about $400,000.

Contract Awarded

★ **Mo., Brentwood (St. Louis, 17, P.O)**—BUNGALOWS—Walter F. Hellmich, Inc., 1037 Big Bend Blvd., St. Louis, Zone 19, 100 one story, 36x40 ft. brick, concrete, steel bungalows, Francis Pl., Rosalie and Eulalie Aves. in Summit Park sub-division, own forces. Over $800,000. Doran-Sahnk, Lee & Yeager, Inc., 1408 Locust St., St. Louis, Zone 3, archt.

Contract Awarded

Mo., Clayton (St. Louis, 5, P.O)—ACADEMY—St. Joseph Academy, Wydown and Big Bend Blvds., Clayton, St. Louis, Zone 5, 3 story, bsmnt., concrete, brick, steel, stone academy incl. auditorium, gymnasium, cafeteria, home economics and science departments, etc. Lindbergh and Litzsinger Rds., St. Louis County, to Michael J. Lawlor Contg. Co., 5632 Terry Ave., St. Louis, Zone 12. Est. over $300,000. Carroll & Dean, 457 N. Kingshighway, St. Louis, Zone 8, archts.

Contract Awarded

Mo., North Kansas City—WAREHOUSE—A. M. Castle & Co., 1132 W. Blackhawk St., Chicago, Ill., general contract warehouse, to S. Patti Constr. Co., 134C Admiral Blvd., Kansas City, Mo. $236,000.

Contract Awarded

★ **Mo., St. Louis**—Walter E. Livengood, Inc. 7000 Watson Rd., Zone 9, 50 two and 3 story, brick, concrete, steel sash bldgs. providing living quarters for 500 families on 27 acre tract, Watson Rd., west of Des Peres Park, known as Tudor Hill and incl. bldg. addn. of Colonial architecture, winding streets, parks, playgrounds, parking areas to provide country village atmosphere, own forces. Over $500,000.

Contract Awarded

★ **Mo., Sugar Creek**—RESEARCH—Standard Oil Co., 910 S. Michigan Ave., Chicago Ill., 1 story, brick, concrete, steel engineering, research bldg., 100 octane plant, cracking plant, etc., to Stone & Webster Corp., 33 S. Clark St., Chicago, Ill. Est. $20,000,000, incl. equip. Bids 7/19.

Contract Awarded

★ **N. H. Tilton**—PLANT—H. A. Kuljian & Co., engrs., 1518 Walnut St., Phila., Pa., awards separate contracts mfg. plant, and auxiliary bldgs., incl. 1 and 2 story, mfg. plant, boiler house, pump house, industrial waste treatment plant for Johns-Manville Corp., 22 E. 40 St., New York, N. Y. $1,000,000.

Contract Awarded

N. J., Trenton—STORE ADDN.—S. P. Dunham & Co., 11 N. Broad St., store addn., alterations, to William C. Ehret & Co., 209 Academy St. Est. $500,000. L. S. Kaplan, 25 N. Montgomery St., archt.

Contract Awarded

N. J., Trenton—OFFICE—Manufacturers Assoc. of N. J., 175 W. State St., office, to Mahony Troast Constr. Co., 657 Main Ave., Passaic, over $205,000. L. G. Adams & F. J. Woodbridge, 204 E. 39 St., New York, N. Y., archts. Voorhees, Walker, Foley & Smith, 101 Park Ave., New York, N. Y., engrs.

Contract Awarded

★ **N. Y., Brooklyn**—HOUSING—New York City Housing Auth., 122 E. 42 St. New York, Zone 17, superstructure and mechanical work for Brownsville Houses, to George F. Driscoll Co. and Moccia Constr. Corp., 41 E. 42 St., New York, Zone 17, $5,861,795***plumbing, to J. L. Murphy, Inc., 340 E. 44 St., New York, Zone 17, $1,098,000***heating to Dierks Heating Co., 43-32 33 St., Long Island City, $562,000*** electrical work, to H. A. Schwartz Co., 163-18 Jamaica Ave., Jamaica, $346,500. Grand total $7,868,295. Bids 8/13.

Low Bidders

N. Y., Brooklyn—STATION FINISH—Bd. Transportation, 250 Hudson St., Zone 13, New York, Oct. 1, station finish for Euclid Ave. Station, Rte. 110, Sect. 10, from Federal Constr. Corp., 101 Park Ave., New York, Zone 17, Proposals (A) $291,903, (B) $289,623, (C) $319,958.

Contract Awarded

★ **N. Y., Buffalo**—WAREHOUSE, etc.—American Stores Co., and Donahy-Faxon Stores, Inc., 424 N. 19 St., Phila., Pa., brick, steel, rein.-con. super market, 1 story 400x500 ft. warehouse, 1 story, 462x684 office bldg., to Turner Constr. Co., 1500 Walnut St., Phila., Pa. $1,250,000. Gantcaume & McMullen, 99 Chauncy St., Boston, Mass., archts.

Low Bidders

N. Y., Cheektowaga—INCINERATOR—Town clk., Town Hall, Aug. 5, incinerator and garage, from Lakeland Constr. Corp., W. Jones, pres., 1703 Main St., Buffalo, Zone 8. $335,000. Nussbaumer & Clarke, Inc., 327 Franklin St., Buffalo, engr.

Contract Awarded

★ **N. Y., New York**—PLATFORM EXTENSIONS—Bd. Transportation, 250 Hudson St., Zone 13, platform extens., various stations on IRT system, to Spencer White & Prentis, 10 E. 40 St., Zone 17. $3,639,000. Bids 9/19.

Contract Awarded

N. Y., New York—HOSPITAL—Memorial Hospital Corp., 444 E. 68 St., Zone 21, altering hospital, to Turner Constr. Co., 420 Lexington Ave., Zone 17. Est. $339,000. Skidmore, Owings & Merrill, 5 E. 57 St., Zone 22, archts

Low Bidders

★ **N. Y., New York**—Bd. Water Supply, 120 Wall St., Zone 5, Sept. 10, Contr. 388, constructing, installing complete structures at 15 localities along portion of Delaware Aqueduct, about 67 mi. long from Shaft 4 in Gardiner, Ulster Co. to Shafts 1A at Hill View Reservoir, Yonkers, from Frazier-Davis Constr. Co., 1319 Macklind St., St. Louis, Mo. $2,955,199.

Contract Awarded

★ **N. Y., New York**—HOUSING—New York City Housing Auth., 122 E. 42 St., Zone 17, foundations and superstructures for Abraham Lincoln Houses, to HRH Constr. Co., 9 E. 40 St., Zone 17, $7,296,000***electrical work, to Arc Electrical Constr. Co., 737 2 Ave., Zone 2, $324,000***plumbing, also heating and ventilating to Jarcho Bros., 306 E. 45 St., Zone 17, $1,048,573 and $461,677 respectively. Grand total $9,130,250. Bids 7/31.

Contract Awarded

★ **N. Y., New York**—HOUSING—New York City Housing Auth., 122 E. 42 St., Zone 17, general contract James Weldon Johnson Houses, Proj. NYS-21, area bounded by E. 112 to 115 Sts., Park and 3 Aves., to Wilaka Constr. Co., 11 E. 44 St., Zone 17, $6,296,000***heating, to Heating Maintenance Corp., 220 E. 138 St., Zone 51, $537,250***electrical work, to E. A. Kahn & Co., Inc., 163-18 Jamaica Ave., Jamaica, $324,000***plumbing, to Lipsky & Rosenthal, Inc., 155 Utica Ave., Brooklyn, Zone 13, $1,095,370. Grand total $8,253,420.

Contract Awarded

O., Cleveland—POWER HOUSE—Mt. Sinai Hospital, Dr. H. L. Rockwood, 1800 E. 105 St., 1 story, 40x85 ft. brick, steel, concrete power house, to Sam W. Emerson Co., 1836 Euclid Ave. Est. $230,000.

Contract Awarded

O., Cleveland—EXCHANGE—Ohio Bell Telephone Co., A. W. Bailey, 750 Huron Rd., 2 story, 100x160 ft., steel, stone top addn. to Michigan-Diamond Exchange Bldg., 7225 Broadway, to Hunkin-Conkey Constr. Co., 1740 E. 12 St. Est. $290,000.

Contract Awarded

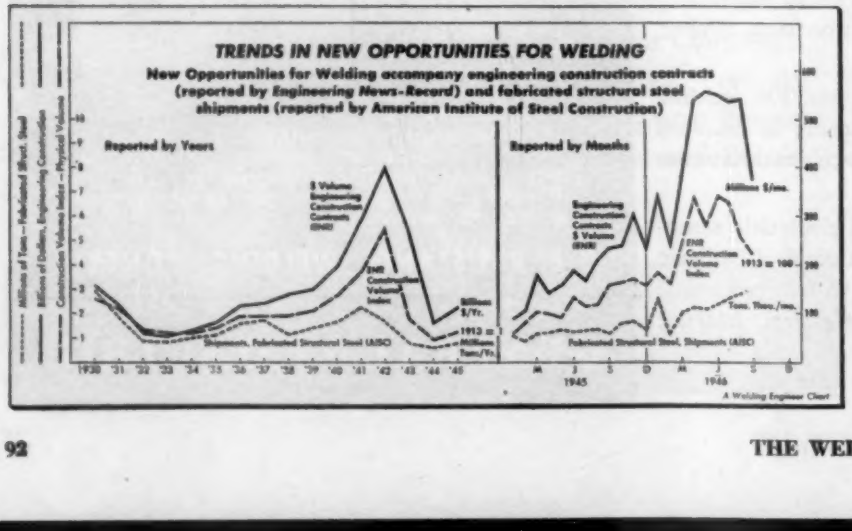
O., Columbus—ROUNDHOUSE—Pennsylvania R. R., D. L. Somerville, ch. engr., Penn Station, Pittsburgh, Zone 22, expanding roundhouse facilities at St. Clair Ave. yards, incl. brick, steel roundhouse addn., to H. M. Boyajohn & Assoc., 990 W. Third Ave. Est. $310,000.

Contract Awarded

O., Danville—PLANT—Ohio Asphalt Paving Corp., c/o John Lupe, mgr., Portsmouth, asphalt plant, Scott's Stone Quarries, to Frownie Bros. Constr. Co., Portsmouth. Est. $100,000.

Contract Awarded

★ **O., Toledo**—PLANT—Grasselli Chemical Div. of E. I. DuPont de Nemours & Co., Du Pont Bldg., Wilmington, Del., 1 story, 34x134 ft., concrete block, steel plant, Stickney Ave. and Matzinger Rd., to Graver Tank & Mfg. Co., Inc., 242 Madison Ave., New York City, N. Y. Est. $1,500,000.


TRENDS IN NEW OPPORTUNITIES FOR WELDING
New Opportunities for Welding accompany engineering construction contracts (reported by Engineering News-Record) and fabricated structural steel shipments (reported by American Institute of Steel Construction)
Reported by Years
Reported by Months
1930 '31 '32 '33 '34 '35 '36 '37 '38 '39 '40 '41 '42 '43 '44 '45
1945
1946
A Welding Engineer Chart

Contract Awarded

★ **O., Toledo**—PLANT—Standard Oil Co., 526 High St., Cleveland, design and construction lubricating oil plant at company's refinery at Cedar Point, Otter Creek, and Bay Shore Rds., East Toledo, to Lummis Co., 420 Lexington Ave., New York, N. Y. Est. $8,000,000. Awarded 8/23.

Contract Awarded

Pa., Sharon—MANUFACTURING—Westinghouse Electric & Mfg. Co., Maloney Bldg., Blvd. of Allies, Pittsburgh, general contract, foundations, masonry and excav., to P. W. Glenn, Sharon***structural steel, to Specialty Steel Products Co., 1500 Electric Ave., Pittsburgh***plumbing, to Stinson Kennedy, 1632 Forbes St., Pittsburgh***electrical work, to Morganstern Electric, 241 1st Ave., Pittsburgh***sprinkler sys., to Grinnell Co., Investment Bldg., Pittsburgh. Est. $200,000.

Contract Awarded

★ †**R. I., Providence**—HOSPITAL—U. S. Eng., Park Sq., Bldg., Boston, 16, Mass., general contract 400 bed general medical and surgical hospital, to E. Turgeon, 614 Turks Head Bldg., $4,662,913, elevators to Otis Elevator Co., 310 18 St. N. W., Wash., D. C., $149,100. Bids 9/10.

Contract Awarded

★ **Tenn., Morristown**—PLANT—American Enka Corp., Asheville, N. C., design and construction synthetic yarn plant, to H. K. Ferguson Co., 1650 Hanna Bldg., Cleveland O. Est. $20,000,000.

Contract Awarded

Tex., Alamo Heights—SCHOOL—St. Peters Church, 111 Barrilla St. Alamo Heights, school to Walsh & Burney, 928 N. Flores St., San Antonio. Approx. $210,000. G. Willis, 603 American Hospital & Life Bldg., San Antonio, archt.

Contract Awarded

★ **Tex., Baytown**—PLANT—Humble Oil & Refining Co., Baytown, 4,500 bbl. daily capacity solvent dewaxing plant, to E. B. Badger & Sons Co., 75 Pitts St., Boston, Mass. $2,000,000.

Contract Awarded

Tex., Houston—PLANT—Carnation Co., 3003 D'Amico St., addnl. milk processing plant units, to Thos. Bate & Sons, 1107 Girard St., approx. $405,000.

Contract Awarded

Tex., Houston—COMMERCIAL BLDG—Craig's Ready to Wear, 819 Main St., altering commercial bldg., force account. $275,000.

Contract Awarded

Tex., Houston—LIBRARY—Rice Institute, Main St., library bldg., to W. S. Bellows Const. Co., 716 N. Everton St., approx. $210,000.

Contract Awarded

★ **Tex., Dallas**—SHOPS, GARAGE, etc.—Continental Trailways Bus Sys., M. E. Moore pres., McKinney and Lamar Sts., shops, garage and maintenance office bldg., to Nathan Wohlfeld, 3936 Glendora St. $500,000. Wyatt C. Hedrick, 1st National Bank Bldg., Fort Worth, archt.

Contract Awarded

Tex., Dallas—City, 4 units of Municipal Market Bldg., to J. J. Fritch, 7000 Harry Hines Blvd. $453,338. Bids. 9/11.

Contract Awarded

★ **Tex., Dallas**—City water Purification Plant Unit 2, (Bachmann, Sect. 2) to J. G. Bartholomew, 311 Constr. Bldg. $556,464. Myers & Noyes, Tower Petroleum Bldg., engrs.

Contract Awarded

★ **Tex., Port Arthur**—PLANT—Gulf Oil Corp., Port Arthur, polymerization and 2 sulphurization units, to The Lummus Co., M. Easperson Bldg., Houston, approx. $450,000 and $700,000 respectively; distillate or oil distillery plant, 8,000 bbl. crude oil daily capacity and distillate plant, 12,000 bbl. oil daily capacity, to E. B. Badger & Son, 75 Pitts St., Boston, Mass., approx. $2,000,000 and $3,000,000 respectively.

Contract Awarded

Tex., Port Arthur—PLANT—Gulf Oil Corp., Port Arthur, refinery plant imprvs., expansion. Owner builds. Approx. $475,000.

Contract Awarded

★ **Tex., Port Neches**—PLANT—Jefferson Chemical Co., Inc., Port Neches, chemical mfg. unit, to Lummus Co. & E. B. Badger & Sons Co., Port Neches, approx. $9,600,000.

A *Convincing* TEST THAT YOU YOURSELF CAN MAKE

THESE "BRONZE BUTTONS" Prove the *Superior* STRENGTH of TITAN BRONZE WELDS

The above series of spot welds were made on greasy cast iron using TITAN Manganese Bronze welding rod. The test piece was chucked in a vise and the bronze spot welds knocked off with a hammer. In every instance the cast iron failed rather than the bronze weld.

This test is so simple you can duplicate it in your own shop . . . yet it proves conclusively that TITAN bronze welds are actually stronger than cast iron. That is why TITAN bronze welding rods are used so frequently for repairing cast iron parts, as well as steel, wrought iron, malleable iron, etc.

Titan Manganese Bronze has the following advantages:

1. *Uniform and easy flowing qualities.*
2. *Low melting point.*
3. *Good bonding properties.*
4. *Low fuming—A comfortable atmosphere for the welder.*
5. *Good machinability of the deposited Bronze Alloy in the weld.*
6. *Doubly Deoxidized (patented process) to produce:*
   - *A. Ductile welds.*
   - *B. High strength welds.*
   - *C. Dense, Non-porous welds.*
7. *Corrosion resistance.*

TITAN *Metal* MANUFACTURING CO.
GENERAL OFFICES AND PLANTS
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Quality Alloys by Brass Specialists
Brass and Bronze Rod · Forgings · Die Castings · Welding Rods

Low Bidders

Va., Blacksburg—Virginia Polytechnic Institute, S. K. Cassell, bus. mgr., Blacksburg, Sept. 20, constructing Agricultural Units 3, 4 and 5 at Virginia Polytechnic Institute, from Southeastern Constr. Co., 218 W. 2 St., Charlotte, N. C. **$454,476.**

Low Bidders

Va., Blacksburg—TREATMENT PLANT—Virginia Polytechnic Institute, Blacksburg, Sept. 20, sewage treatment works, from A. H. Guion & Co., Wilkinson Blvd., Charlotte, N. C., **$255,427.** Begg & McGaughey, Blacksburg, engrs.

Low Bidders

Va., Denbigh—PUMPING STATIONS—Hampton Roads Sanitation Dist. Comn., Flatiron Bldg., Sept. 6 Norfolk, Center Ave. and Hilton School Pumping Stations of th Warwick Co. Trunk Sewer, from Langley Constr. Co., Hampton. **$71,789.**

Contract Awarded

Tex., Lott—DISPOSAL PLANT—City, c/o Mayor, sanitary sewers, sanitary sewerage sys., disposal plant, trickling filter, to J. D. George, 3331 Parkwood Dr., Houston, **$50,267.** Est. $50,000. Bids 9/4, awarded 9/10.

Low Bidders

Tex., Odessa—SCHOOL—Ector County Ind. School Dist., Odessa, school, from T. C. Bateson Constr. Co., 622 Irwin-Keasler Bldg., Dallas. **$340,140.**

Contract Awarded

Tex., Sah Marcos—H. Williamson & Assoc., San Marcos, 4 story hotel, to Gordon Fulcher, 2411 Scenic Dr., Austin, approx. **$300,000.**

Contract Awarded

Tex., Sheridan—SCHOOL—Sheridan Independent School Dist. school, to J. F. Walker, c/o Sheridan Lumber Co., Sheridan. Est. **$205,000.**

Contract Awarded

★ **Tex., Texas City**—PLANT—Carbon & Carbide Chemical Corp., 30 E. 42 St., New York, N. Y., design and construction 55x55x27 ft. compressor bldg. 51x160x100 ft. equip. bldg. 20x13x202 ft. gas separation plant control bldg. three 29x60x20 ft. pump house, 12x19x10 ft. electric control bldgs., to Ford, Bacon & Davis, c/o H. M. Hays, Texas City, approx. **$4,000,000.**

Contract Awarded

★ **Va., Richmond**—PLANT—E. I. du Pont de Nemours & Co., du Pont Bldg., Wilmington, Del., sulphuric acid plant, to Leonard Constr. Co., 37 South Wabash Ave., Chicago, Ill. Over **$500,000.**

Low Bidders

Va., Richmond—Henrico Co., Sept. 19, Tuckahoe, School from C. E. Nuchols, 1103 E. Main St. **$265,000.** Dixon & Norman, 1103 E. Main St., archts.

Contract Awarded

Va., Richmond—OFFICE—Standard Oil Co. of New Jersey, Richmond Trust Bldg., office bldg., Broad and Hamilton Sts., to J. Kennon Perrin Co., Fifth and Cary Sts. $500,000. Carneal & Johnston, Atlantic Life Bldg., archts.

Low Bidders

Wash., Newport—TREATMENT PLANT—Town, Town Hall, Sept. 11, treatment plant, trunk sewer and lateral sewers, from Rushlight Automatic Sprinkler Co., 407 S. E. Morrison St., Portland, Ore. **$160,033.**

Contract Awarded

★ **Wash., Seattle**—ARTS BLDG.—Highline Public Schools 253 S. 152 St., Zone 88, general contract industrial arts bldg., to Lewis Constr. Co., 3447 4 Ave. S. **$574,316.** Bids 8/21.

Contract Awarded

Wash., Seattle—PLANT—The Texas Co., 135 E. 42 St., New York 17, N. Y., oil storage and distr. plant on Harbor Island, with facilities for tankers, tank cars and tank trucks, day labor. **$268,020.**

Contract Awarded

W. Va., Bluefield—City, c/o Bd. Directors, Bluefield, 800 car municipal parking bldg., to C. L. Lewis, Lynchburg, Va., **$397,500.**

Contract Awarded

Wis., Madison—Wisconsin Telephone Co., 722 N. Broadway, Milwaukee, Zone 2, 7 story 72x116 ft., concrete, steel, brick central office bldg. addn., to J. H. Findorff & Son, 601 W. Wilson St. Est. **$600,000.** W. G. Herbst & Assoc., 1249 N. Franklin Pl., Milwaukee, archts.

Low Bidders

Wis., Marshfield—City, Water & Electric Dpt., Sept. 27, boiler room addn., from Thomsen-Abbott Constr. Co. **$189,755.**

Low Bidders

†**Wyoming**—POWER TRANSFORMERS—Bureau Reclamation, Court House, Denver 2, Colo., Aug. 30, transformers for Kortes Power Plant, Kortes unit, from Pennsylvania Transformer Co., 808 Ridge Ave., Pittsburgh, Pa. **$119,999.**

CANADA

Contract Awarded

★ **Alta., Taber**—FACTORY—Canadian Sugar Factories, Raymond, sugar factory, to Dominion Const. Co. Ltd., 509 Richards, Vancouver, B. C., about **$2,250,000.** J. H. Ballon, c/o owner & Stearns Roger Mfg. Co., 1720 Calif. Ave., Denver, Colo., engrs.

Contract Awarded

★ **N. B., Edmundston**—MILL—Fraser Companies, Ltd., A. Crabtree, pres., Plaster Rock, pulp mill, to Foundation Co. of Canada, Ltd., 1538 Sherbrooke St. W., Montreal, Que., about **$4,000,000.** F. O. Smith, c/o owner, engr.

Contract Awarded

N. S., Halifax—SCHOOL—School Bd., Sackville St., school, to Standard Const. Co. Ltd., Upper Water St. Est. **$220,360.** C. E. Fowler, Barrington St., archt. CD

Contract Awarded

★ **Que., St. Johns**—PLANT—Singer Mfg. Co., Ltd., 165 St. Paul St., tool and needle plant, to Anglin-Norcross, Quebec, Ltd., 892 Sherbrooke St., W., Montreal, about **$500,000.** T. Pringle & Son Ltd., 485 McGill St., Montreal, engr.

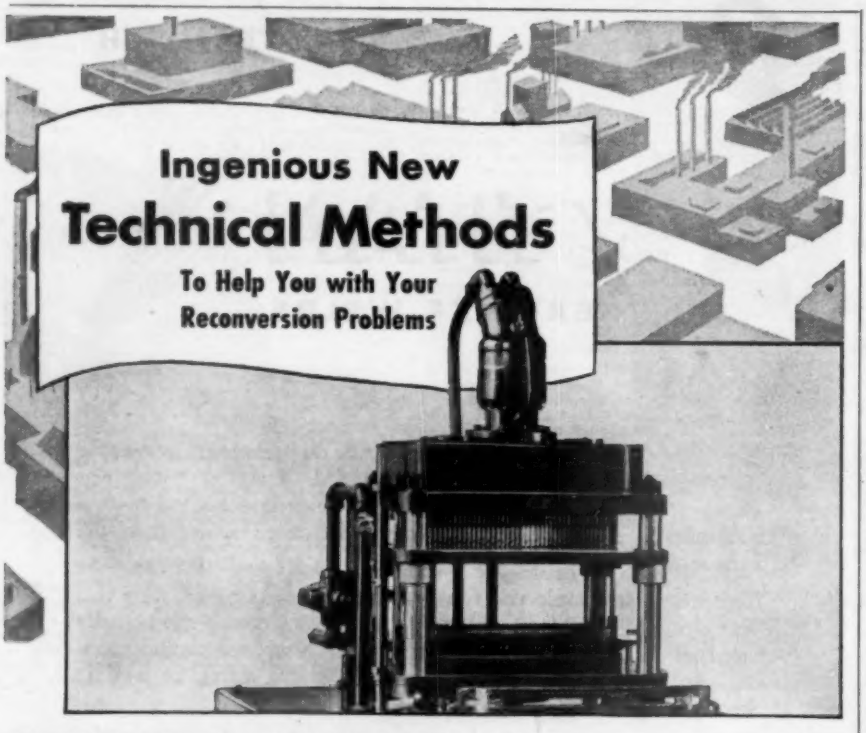
Rails

Contract Awarded

★ **Fla., Wildwood**—TERMINAL—Seaboard Air Line R7, W. D. Simpson, ch. engr., S. A. I. Ry. Bldg., Norfolk 10, Va., terminal, double tracking of main railroad lines, to George D. Auchter Co., foot E. 56 St., Jacksonville. **$500,000.**

Low Bidders

Calif., San Francisco—TROLLEY SYS.—City and San Francisco Co. Pub. Utilities Comn., City Hall, Sept. 24, trolley sys., Union St. coach line from Montgomery and Washington Sts. to Presidio, Spec. 262, from Abbett Electric Co., 472 Tehama St. **$57,004.**



12,000 Holes per Hour! With New Gearless Multiple Spindle Drillhead!

The Zagar Gearless Drillhead can accommodate up to 400 drills in one head—drill up to 400 holes at one time! This revolutionary unit runs noiselessly and vibration-free on needle, tapered roller and precision ball bearings, and is lubricated by a patented automatic oiling system to insure trouble-free operation.

With this unit all holes are drilled at one pass, and valuable time is saved by the elimination of indexing and extra handling. It may be used on standard drill presses, or furnished as a complete hydraulic machine by the factory.

Another time saver, as well as a help on a tedious job, is chewing gum. The simple act of chewing seems to make the work go faster, easier—helping to relieve worker's fatigue—so that a better piece of work can be turned out with greater safety. Wrigley's Spearmint Gum may be used even when both hands are busy—right where the work is being produced.

You can get complete information from
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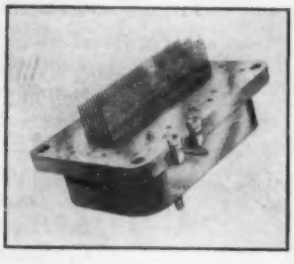
23881 Lakeland Blvd., Cleveland 17, Ohio



Zagar 220 Spindle Gearless Drillhead

AA-98

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the New CESCO Speed-Shift

HERE IT IS! The CESCO Aristocrat Welders Goggle—with patented coil-spring suspension. A quick flip moves the goggle onto the forehead or back into position. Saves time! Promotes efficiency!

That's not all—this goggle increases welders' comfort too. The spring action is mild enough to eliminate pressure. The cups rest comfortably, and are adjustable to individual facial requirements. The headgear is made of lightweight, flexible, form-fitting plastic, and is easily adjusted to any head size.

***WRITE** for literature and prices.*
For quick delivery, get your order in soon.

1. Goggle in regular welding position

2. Pull outward and upward with either hand

3. Goggle rests on forehead during layout or inspection of work

This CESCO *Air-Flow* Helmet is proving its worth to welders

CESCO'S recent development—the *Air-Flow* Welding Helmet—is consistently proving to be a remarkable success. Its superior, exclusive method of air feeding disperses fumes and heat—reduces fatigue, increases production. It combines assured welding safety and "air-conditioned" comfort. For complete information write for BULLETIN B.

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Miscellaneous—Including Equipment Repairs & Hard-facing

Contract Awarded

★ †**New York and New Jersey**—DREDGING—U. S. Eng., 120 Wall St., New York, Zone 5, N. Y., dredging approx. 116,000 cu. yd. place measurement incl. ledge rock and 41,800 cu. yd. place measurement of material other than ledge rock from New York and New Jersey Channels, Sect. 7, Rock Area 13, to Arundel Corp., Pier 2, Pratt St., Baltimore, Md. **$1,282,424.** Bids 7/31.

Low Bidders

N. Y. Idlewild—AIRPORT GRADING—Comr. Marine & Aviation, Pier A, foot of Battery Pl., North River, New York, Zone 4, Sept. 4, Contr. 2492, electrical, telephone and communications conduit sys. at Municipal Airport, etc., Contr. 29, from Rao Electric Equip. Corp., 150 E. 41 St., New York. **$3,577,000.**

Contract Awarded

†**South Carolina**—DREDGING—U. S. Eng., Custom House, Charleston, maintenance dredging, 35 ft. Cooper River and Town Creek channels, Spec. 38-081-47-2, to The Arundel Corp., Elkton, Wilmington, Del. **$546,810.**

★ †**Tennessee**—DAMS—Tennessee Valley Auth., Knoxville, completing Watauga and South Holston Dams, own forces, **$17,666,000.**

Low Bidders

†**Washington**—RULLING, DAM—Bureau Reclamation, Customhouse, Denver 2, Colo., Aug. 26, crest railing at Grand Coulee Dam, Columbia Basin Proj., Spec. 1419, from Columbia Electric & Mfg. Co., S. 123 St., Spokane. **$446,799.** W. R. Young, ch. engr.

Low Bidders

★ †**Nebraska**—DAM—Bureau Reclamation, McCook, Sept. 4, Enders Dam and dike on Frenchman Creek, Spec. 1410, from Wunderlich Contg. Corp., Jefferson City, Mo. **$4,109,927.**

Marquette Instant Arc Welders give you the utmost in welding performance. Faster Arc Striking makes welding easier, faster and smoother on light sheet metal. On heavy jobs, the Automatic Voltage Control assures the best arc and reduces spatter on high heats.

Instant Arc Striking is achieved thru Marquette's newly designed transformer which delivers smooth welding power of the correct voltage-current ratio thru the entire welding range.

Model 262 C has Capacitor for High Power Factor, Telnic Bronze plugs and sockets, a wide welding range of 20–275 amperes, and is fully equipped. Models: 262 and 262 C, 20–275 amps.; 261 and 261 C, 20–200 amps. Write for literature.

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MARQUETTE MFG. CO. INC.
MINNEAPOLIS 14, MINN.

Low Bidders

★ **N. Y., Idlewild**—AIRPORT APRON UNDERPASS—Comr. Marine & Aviation, Pier A, foot of Battery Pl., North River, New York, Zone 4, Aug. 26, apron underpass for Van Wyck Approach Rd. at Municipal Airport, Contr. 2495, from Del Balso Constr. Corp., 220 E. 42 St., New York. **$2,545,470.**

Low Bidders

★ **N. Y., Idlewild**—AIRPORT GRADING—Comr. Marine & Aviation, Pier A, foot of Battery Pl., North River, New York, Zone 4, Aug. 29, Contr. 2493, general grading, Municipal Airport, incidental work, Contr. 30, from Davis Constr. Co., Charlot Ave., Hicksville. **$695,875.**

Low Bidders

★ **N. Y., Idlewild**—AIRFIELD ROAD—Comr. Marine & Aviation, Pier A, foot of Battery Pl., North River, New York, Zone 4, Sept. 9, Contr. 2494, grading, drainage and structures for Van Wyck Approach Rd. at Municipal Airport, Contr. 31, from Gull Contr. Co., Inc. and L. G. Defelice & Sons, Inc., 3315 Lawrence St., Flushing. **$1,448,485.**

Contracts Awarded

★ †**Arizona**—Bureau Reclamation, Customhouse, Denver, Colo., hydraulic turbines and governors for Davis Power Plant, Davis Dam Proj., Arizona-Nevada, Spec. 1287, to Baldwin Locomotive Works, Eddystone, Pa. **$2,199,586.** Bids 6/10.

Low Bidders

★ †**California**—Bureau Reclamation, Antioch, Sept. 6, earthwork, concrete lining, structures, Sta. L-185 plus 00 to Sta. L-774, plus 00, Delta-Mendota Canal Delta Div., Central Valley Proj., Spec. 1435, from Morrison-Knudsen Co., 111 Sutter St., San Francisco, and M. H. Haaler, Box 387, Santa Ana. **$3,625,121.**

Contracts Awarded

Calif., Pasadena—Rocket Div. General Tire & Rubber Co., 1030 E. Green St., launcher bridge, bridge support carriage, connecting bridge, barges and counterweight car for variable angle launcher proj., Morris Dam, San Gabriel Canyon, to United Concrete Pipe Corp., Box 1, Sta. H, Los Angeles. **$424,519.**

Low Bidders

★ **Ill., Chicago**—SUBWAY—City of Chicago, Subways & Superhighways, 20 N. Wacker Dr., Aug. 29, Dearborn St., Subway, Contr. D-8, from Peter Kiewit Sons Co., 38 S. Dearborn St., and S. A. Healy Co., 221 N. LaSalle St. **$8,235,135.**

Low Bidders

★ †**Washington**—Bureau Reclamation, Coulee Dam, Aug. 20, first 12.3 mi. East Low Canal for Columbia Basin Irrigation Sys., Spec. 1422, from Utah Constr. Co., 5250 S. State St., Salt Lake City, Utah, and Winston Bros. Co., 1470 N. W. Bank Bldg., Minneapolis, Minn. **$3,977,136.**

Contract Awarded

★ †**Washington**—Bureau Reclamation, Customhouse, Denver 2, Colo., 3 generators for Grand Coulee Dam, Columbia Basin Proj., to Westinghouse Electric Corp., Gas & Elec. Bldg., Denver, Colo., **$2,932,862.**

Contracts Awarded

★ †**Washington**—Bureau Reclamation, Customhouse, Denver 2, Colo., 3 turbines for Grand Coulee Dam power plant, to Newport News Shipbuilding & Drydock Co., Newport News, Va., **$1,983,569**; 3 governors for turbines to Woodward Governor Co., Rockford, Ill., **$89,739.**

Contract Awarded

†**Washington**—Bureau Reclamation Customhouse, Denver, Zone 2, Colo., trashracks for main units of right powerhouse at Grand Coulee Dam to Joshua Hendy Iron Works, 544 Market St., San Francisco, Calif., **$310,052.** W. R. Young, ch. engr.

Low Bidders

★ **Washington**—Bureau Reclamation, Coulee Dam, August 7, earth fill dam, 1,900 ft. long and 110 ft. high, at Long Lake, from J. A. Terteling & Sons, 4011 Fairview Ave., Boise, Ida. **$1,770,592.**

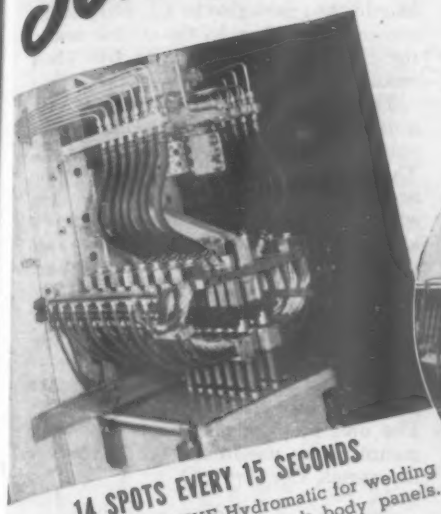
Contract Awarded

★ **British Columbia**—HYDRO-ELECTRIC DEVELOPMENT—Powell River Co., Ltd., Powell River, hydro-electric development, addn. to Scanlon Dam, new spilling section and gates, to B. C. Bridge & Dredging Co., Ltd., 540 Howe St., Vancouver. About **$400,000.** H. J. P. Moorhead, Powell River, resident engr.

★ **Mexico**—Comision Nacional de Irrigacion, Balderas 94, Mexico, D.F., earth & rockfill dam, to Morrison-Knudsen de Mexico S.A., Ave. Juarez 76-509, Mexico. 12,000,000 pesos. CD

Some reasons why

IT PAYS TO DESIGN for RESISTANCE WELDING



14 SPOTS EVERY 15 SECONDS

Typical PROGRESSIVE Hydromatic for welding 11 gage stake pockets to truck body panels.

WELDS BOTH R.H. AND L.H. FENDERS AT 175/hr.

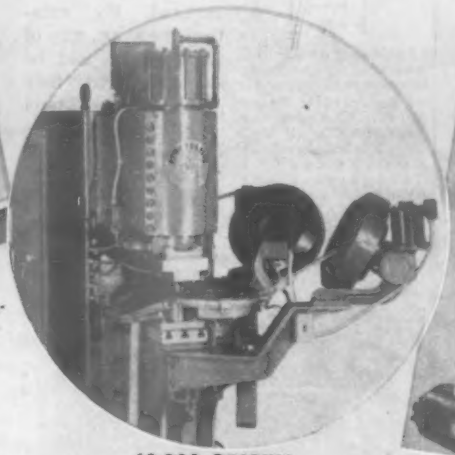
PROGRESSIVE Duplex Ultra-Speed welds 18 points on each while the other side is being loaded.

A CABINET DRAWER EVERY 15 SECONDS

Typical PROGRESSIVE Hydromatic assembles drawers for stoves, cabinets, refrigerators, etc., with up to 48 spot welds.

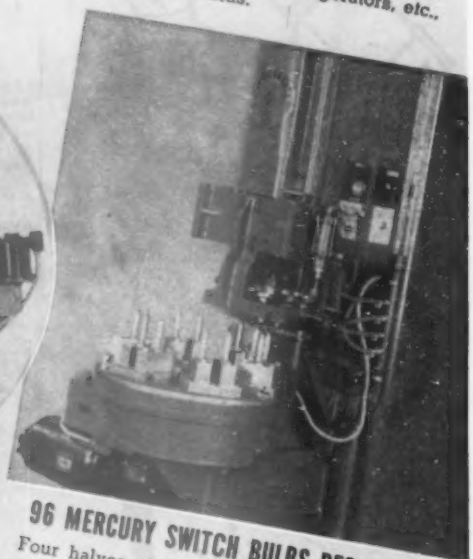
OVER 100 SUB-ASSEMBLIES PER HOUR

Welding cross sill reinforcements to underbodies with a PROGRESSIVE Ultra-Speed.



10,000 BEARING CUPS PER DAY

Automatic loading, feeding, indexing and ejection are built into this PROGRESSIVE Projection Welder.



96 MERCURY SWITCH BULBS PER MINUTE

Four halves of two mercury switch bulbs are projection welded simultaneously on this six-stage dial indexing PROGRESSIVE Press Welder.

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IT PAYS TO WELD

For news of the latest developments in resistance welding equipment and methods, influencing product design, ask to be put on the mailing list for the Progressive "WELDING PICTORIAL".

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PROGRESSIVE Welder Co 3050 E. OUTER DRIVE • DETROIT 12

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AMERICAN AGILE CORPORATION

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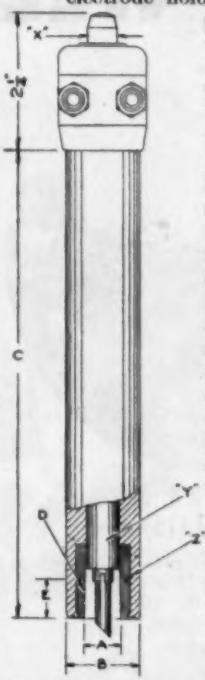
New Products to Use

To Secure Additional Information, Turn to Page 105

R-W Electrode Holder

1 A NEW water-cooled ejector-type electrode holder said to be leak-proof regardless of water pressure or temperature is offered by Weiger Weed for resistance-welding machines. Equipped with a hard-alloy taper socket of high electrical conductivity and a stainless-steel ejector tube, the holder shown in the drawing has a ½-in.-diameter hardened stainless-steel knock-out plug with a double bearing support. Spring action of the plug assures free water ports and proper seating of the electrode tip. The holder may be adjusted in three positions of 15, 30 and 45 degrees from the vertical. By rotating the horn, any of these angles can be used in another plane. Other barrel lengths and taper sockets can be made to specifications. WEIGER WEED AND CO., Detroit 14.



(A) Major taper diameter; (B) Body diameter; (C) Length of holder; (D) Morse taper; (E) Taper engagement with tip; (X) Stainless-steel knockout; (Y) Stainless-steel knockout tube; (Z) Copper-alloy tip socket

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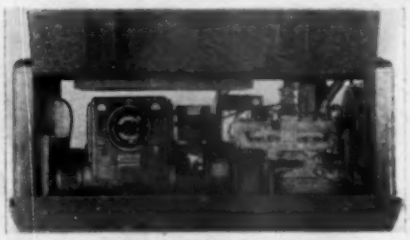


Gas-electric driven 300-amp arc welder does the job regardless of power supply

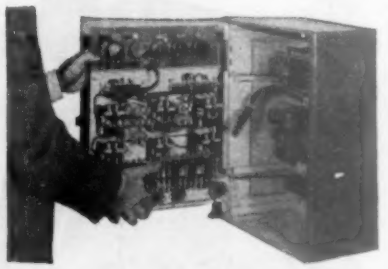
Gas-Electric Arc Welder

2 BUILT to run on 220-440 volt operation is a new combination gasoline-electric 300-amp welder mounted on a heavy solid shaft coupled to a Chrysler 6-cylinder industrial engine through an over-running clutch coupling. The latter allows the gasoline engine to drive the welding generator positively. Should the gas-engine be stopped and the generator be driven by the electric motor, the clutch will over run or free wheel automatically.

The induction motor is equipped with a double-throw knife which changes the voltage to either the 220 or 440 position. The motor is started by a pushbutton across-line contactor designed to work in conjunction with voltage changeover knife switch; hence no changes are necessary in the contactor for voltage operation.

In the event that the electric power fails because of line failure, or overload during the peak load operating point of the day, it is possible to start up the gasoline engine and carry on the welding. The unit may be placed on a portable mounting for use in the field. HOBART BROTHERS, Co., Troy, O.

★ ★



G-E's improved line of sequence and sequence-weld timers for high production

Sequence-Weld Timers

3 GENERAL ELECTRIC has redesigned its line of sequence and sequence-weld timers for resistance welding by including an improved electronic timing circuit which makes possible the consistent welding speed essential to high-production welding with short timing intervals. The sequence timer, designed for the highest degree of weld consistency, coördinates the mechanical operation of an air or fluid-operated spot or projection welder with the flow of the welding current, as determined by a synchronous-precision weld timer. For less exacting applications, the sequence-weld timer provides the necessary control of both mechanical sequence of operation and non-synchronous control of weld time. The timing control station can be mounted on the welding machine or elsewhere for the convenience of the operator. General Electric Co., Apparatus Department, Schenectady, N. Y.

Special Offer!

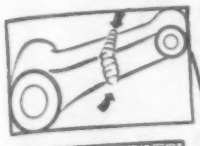
FOR SMALLER SHOPS WITH WELDING PROBLEMS

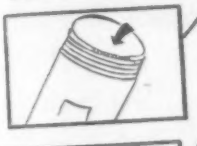
EUTECTIC

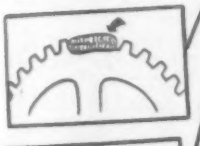
Low Temperature

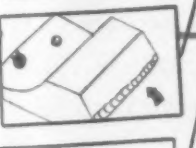
WELDING RODS* and FLUXES

DO THESE EVERYDAY JOBS faster, better, economically









Here's your opportunity to try a special assortment of the revolutionary EUTECTIC *Low Temperature* WELDING RODS* and FLUXES—the new development in welding that helped to lick many wartime production and maintenance problems. Now, with these superior quality welding materials you can take on the many jobs you formerly turned down—and save time, money, and materials.

EUTECTIC *Low Temperature* WELDING RODS* are a new type of welding alloys which—*1. Bond to base metals well below the melting point of the base metal. 2. Form exceedingly strong joints through surface alloying. 3. Give faster, better bonds at lower cost. 4. Avoid the dangers of stress and distortion characteristic of fusion welding and brazing.*

"A" ASSORTMENT FOR GAS WELDING —

9 DIFFERENT ALL-PURPOSE EUTECRODS (incl. FLUXES)

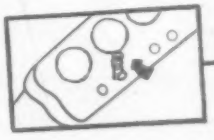
USES	ROD NO.	
CAST IRON (GAS)	EUTECROD	14
CAST IRON (SEALING CRACKS etc.)	EUTECROD	15
STEEL, CAST IRON	EUTECROD	16
BRASS, BRONZE, COPPER	EUTECROD	18
BRASS, BRONZE, COPPER, STEEL	EUTECROD	1800
CAST & SHEET ALUMINUM (GAS)	EUTECTRODE	2100
FRICTIONAL WEAR & JOINING	BRONZOCHROM	185
ABRASIVE WEAR - EXTRA HARD	EUTECHROM	1
DELICATE ALUMINUM WORK	EUTECROD	190

$59.68

Gross Weight 39 lbs.

"B" ASSORTMENT FOR GAS & ARC WELDING —

10 DIFFERENT EUTECRODS WITH FLUXES



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No special equipment is required, any ordinary torch or arc welding equipment can be used. Use coupon below to order your selection of the assortment desired — each packed in a special carton with appropriate EUTECTOR Flux and full instructions. Shipped C.O.D. (25% deposit required with order), or send company letterhead with 3 trade references.

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VISIT OUR BOOTHS A-180 AND G-103 NATIONAL METAL CONGRESS ATLANTIC CITY NOVEMBER 18TH—22ND

*Trade-Mark Reg. U. S. Pat. Off.

F-125 THE ROAD TO PRODUCTION

This is the Road YOU Live by . . . .

History's hungriest market for manufactured goods is lined up beside the world's greatest facilities . . . still waiting.

It seems like simple common sense, then, to face the fact that YOU have a tremendous personal stake in seeing that more and better goods are produced through YOUR efforts than ever before. The Road to Production leads to individual security through PERMANENTLY improved living standards. It can take us far, or to a dead end, depending upon how each of us adapts himself to that first essential . . . MORE OUTPUT.

Federal specializes in upping efficiency through automatic welding, which offers more improvements in metal goods manufacture than any other single method or "tool" we know. Wherever metal fabricating or fastening on a production basis is a problem, resistance welders of one type or another usually provide a profitable solution.

Federal makes every type of resistance welder . . . many specially developed by our welding engineers for highly special needs.

Random examples of every-day production "step-ups" with Federals are illustrated at right. There's a Federal representative in every key city qualified to show you similar methods to speed YOUR goods on the Road to Production.

Production Provides Permanent Personal Prosperity

Look for this Sign at the Metal Show

At Exhibit No. F-125 Federal has a production line in action, teaming Warco Production Presses with Federal Production Welders and making an interesting, marketable product.

THE Federal MACHINE

SUBSIDIARIES
Sommer and Adams Co., Cleveland—SPECIAL HIGH PRECISION MACHINES
The Warren City Mfg. Co., Warren—WARCO PRESSES and PRESS BRAKES

FOUR SEAM WELDS AT ONCE . . . SIX SETS PER MINUTE
PROJECTION WELDING 11,500 AUTO DOOR HINGES PER SHIFT
SPOT WELDING DEEP FREEZER PARTS
BUTT OR MITRE WELDING ALUMINUM SASH
FLASH WELDING 300 STEEL DRUMS PER HOUR

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MEMBER RESISTANCE WELDER MANUFACTURERS ASSOCIATION RWMA

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To Save Time On Many Welding Jobs!

Powerful Van Dorn Portable Electric Grinders can shave hours off your welding jobs . . . and save money and muscle, too! 1. They prepare surfaces for welding by removing metal, rust, scale, oxidation, old paint. 2. They smooth welds by removing excess metal. 3. They clean and buff surfaces for finishing.

Ask your nearby Van Dorn Distributor for full information on these time-saving tools. Send for our free catalog for details on Portable Electric Grinders and many other Portable Electric Tools for metal working. Address: The Van Dorn Electric Tool Co., 734 Joppa Road, Towson 4, Maryland.

Better Brushes!

Van Dorn "Whirlwind"* Wire Brushes have each tuft locked in to stay! That means they're tougher, denser, last longer. Six wheel sizes: 4" to 12". Three wire sizes. Three wheel thicknesses.

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FOR POWER SPECIFY

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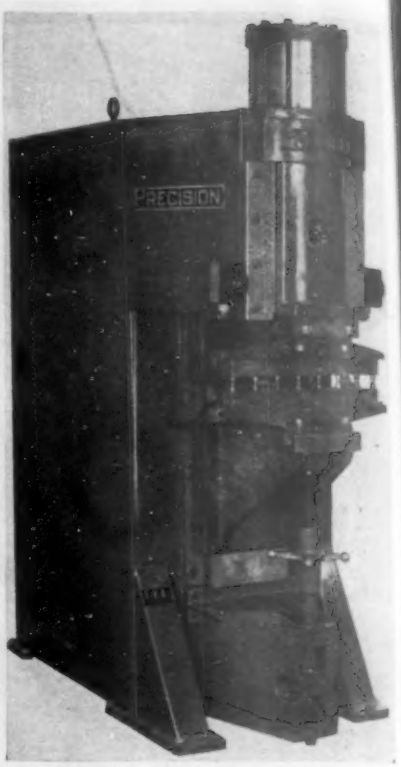
(DIV. OF BLACK & DECKER MFG. CO.)

PORTABLE ELECTRIC TOOLS



Type AVA-3 press-type spot and projection welder made in four standard sizes

Press-Type Welders

4 CONSTRUCTED and styled in the machine-tool manner are the new AVA (air vertical action) spot and projection welders. These units are made in four standard sizes ranging from 30 to 500 kva with maximum pressures up to 18,000 lb. Outstanding features include: (1) honed brass air cylinders with cushion and universal connection to ram; (2) fabricated steel frame with an integral overhang arm; (3) extra long ram with vee-ways fully contained in gibs and shrouded at top from dirt; (4) gibs adjustable for wear and providing full length lubrication; (5) adjustable coolant flow; (6) solenoid valve removable from air terminal unit assembly without the need of disconnecting piping. PRECISION WELDER AND MACHINE CO., Cincinnati 10.

* *

All-Position Electrode

5 CONFORMING to AWS-E6012 specifications and NEMA standards is a new all-position electrode (No.107) for work involving poor fit-up on mild steel. Recommended for single or multiple pass welding on rusty or dirty plates or sections, this versatile electrode is said to work equally well on a-c or d-c straight or reverse polarity. Some specific uses include the welding of sections of hopper and box cars, scaling flues in boilers and general maintenance and repair. It produces a shallow, flexible arc that permits less-skilled operators to obtain good results, states manufacturer. WILSON WELDER and METALS CO., New York City 17.

(*Continued on page 126*)

Allowable Working Pressure on Welded Flat Tank Heads

By ELMER JOHNSON

Min $t_t = 1.25\ t_s$

ASME formula

$$t_h = D\sqrt{\frac{.50 \times P}{11{,}000}}$$

Where:

t_h = Thickness of head

D = Diam of tank in inches

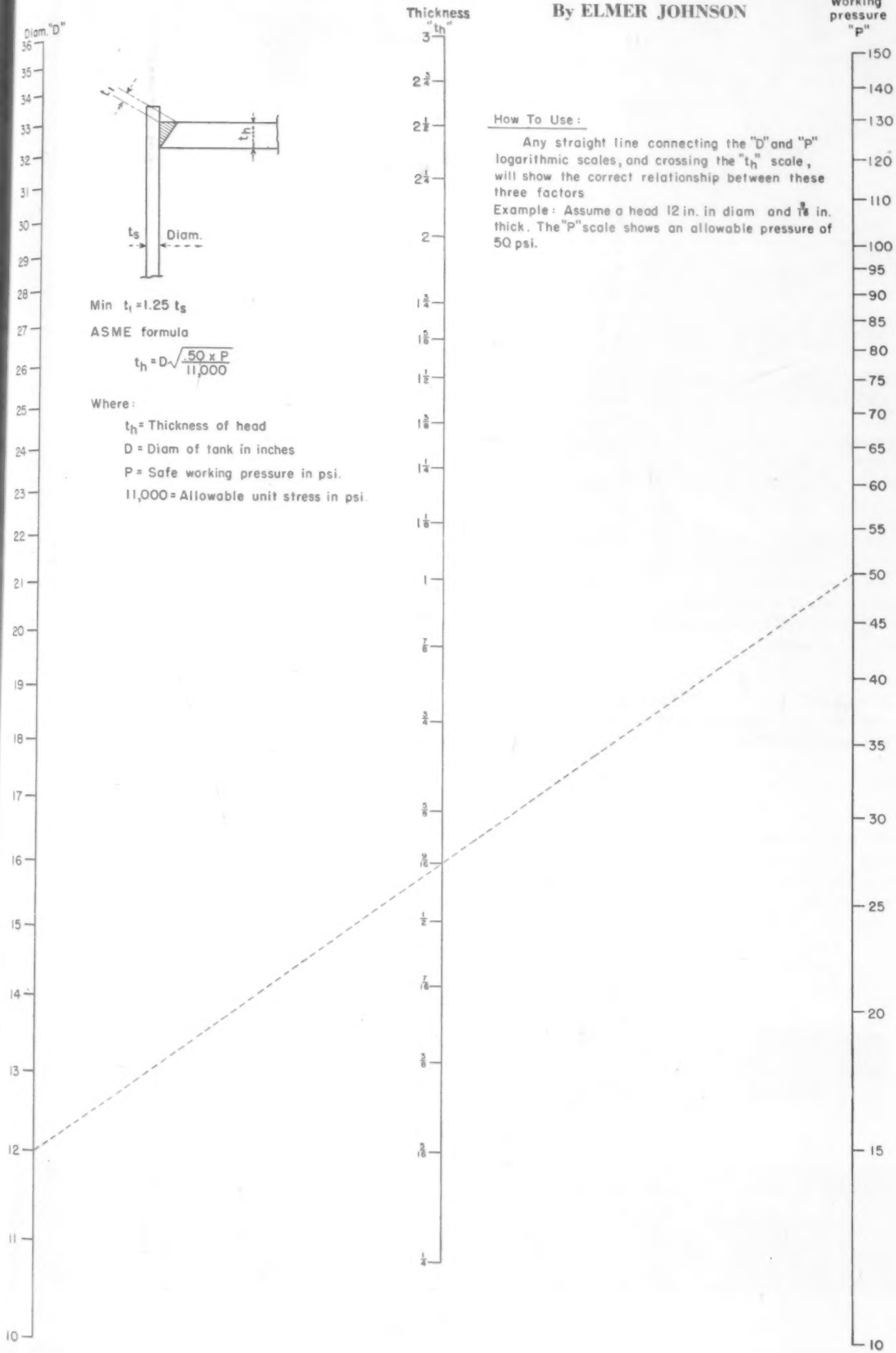
P = Safe working pressure in psi.

11,000 = Allowable unit stress in psi.

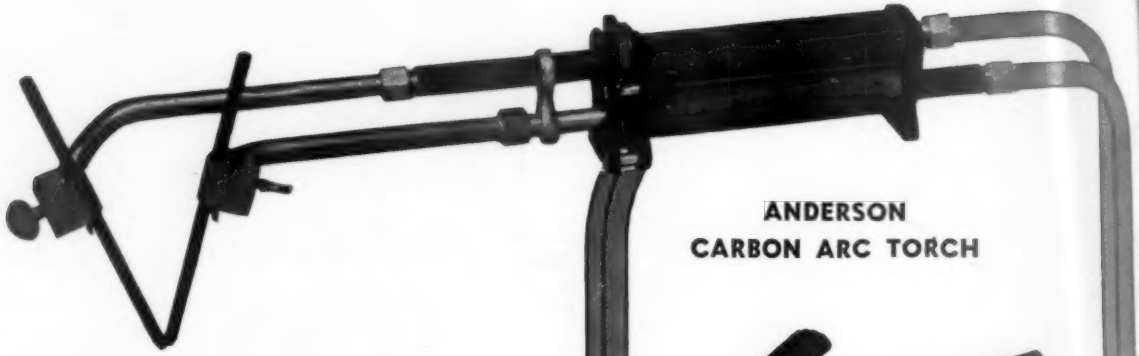
How To Use:

Any straight line connecting the "D" and "P" logarithmic scales, and crossing the "t_h" scale, will show the correct relationship between these three factors

Example: Assume a head 12 in. in diam and $\frac{5}{16}$ in. thick. The "P" scale shows an allowable pressure of 50 psi.



THE WELDING ENGINEERS' ENGINEERING DATA SHEET No. 74



ANDERSON
CARBON ARC TORCH

EASY-TO-USE WELDING ACCESSORIES

ELECTRODE HOLDER — The Anderson Electrode Holder is one of the few fully-insulated holders on the market. It's compact, well balanced, light-in-weight and all metal parts are fully protected against spatter. Accommodates up to ¼" electrodes and holds them firmly at their points of contact.

ANDERSON
"WK" ELECTRODE HOLDER

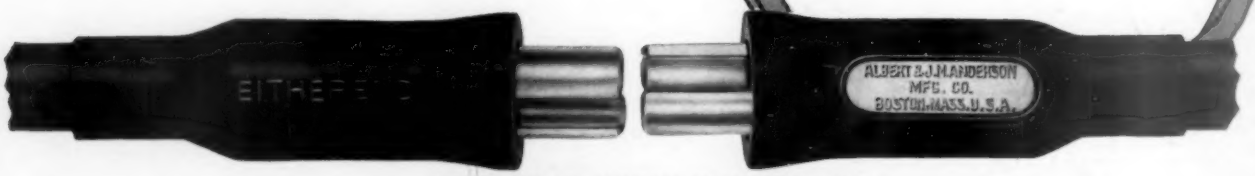
CARBON ARC TORCH — The Anderson Carbon Arc Torch is ideal for welding non-ferrous metals and for localized pre-heating, soldering, brazing and hard surfacing. It's lightweight, nice balance makes it a fine tool. Holders accommodate carbons from ¼" to ½" in diameter.

HEAVY-DUTY
PLUGS AND
RECEPTACLES

EITHEREND CABLE CONNECTOR — Quick, sure welding cable connections without hunting for mating ends. *Either end* fits without use of tools. Many sizes — with or without retaining hooks — provide a wide range of on-the-job applications for Eitherend.

WELDING
GROUND CLAMPS

OTHER ACCESSORIES — Anderson heavy duty plugs and receptacles, and ground clamps are job-tested — thoroughly reliable. Welding equipment by Anderson is built for long life and easy, practical use. Specify Anderson Welding Equipment for every welding job.



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Manufacturers' Literature as well as further information on New Products described in this issue are important "working tools" for design and production departments. To make it easy to keep up-to-date, THE WELDING ENGINEER will request manufacturers to send readers the literature in which they are interested. Just fill out card—we do the rest.

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Address 3217 Lewis Ave.
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Your Name John Smith
Your Title Chief Engineer

THE WELDING ENGINEER
520 No. Michigan Ave., Chicago 11

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20 RAILROAD MAINTENANCE—Air Reduction Sales Co., New York City, 17. 48-page book "Oxy-acetylene Flame Processes and Arc Welding in Railroad Mechanical Operations" describes approved methods of doing many shop maintenance and fabrication jobs. These include: brazing and arc welding broken cylinders and frames; building up and flame-hardening piston heads; removing bolts with the oxygen lance, shape-cutting parts for locomotive frames; fabricating driving boxes; welding tubes and flues in the fire box end of the flue sheet; welding freight car bodies; fabricating car bodies by flame-cutting and arc welding; heat treating car couples; welding and brazing pipes; cutting scrap car axles, etc. The booklet also explains the railroad technical services offered by Airco, etc.

21 CONTACT WELDING—Philips Laboratories, Inc., New York City 17. Technical Review (Vol. 8, No. 6) treats among other subjects, that of contact welding. It describes such methods as "touch welding" by use of a new contact electrode which has a coating that contains a large part of the core metal in the form of a fine powder.

22 MACHINE TOOLS—DoALL Co., Des Plaines, Ill. 60-page book "Your Life in the Machine World," written by Leighton A. Wilkie, chairman of the above company, traces the high spots of mechanical and industrial developments in the United States and emphasizes the individual and collective results of the various inventions that have influenced the course of history and world economics.

23 CARBON BRUSHES—The Ohio Carbon Co., Cleveland 11. 32-page catalog (No. 15) describes a line of carbon brushes for the various makes of d-c welders. Illustrations show the correct brush to be employed with the particular welder. A "progressive size table" lists specifications and gives page numbers of illustrations for quick reference.

24 WELDING RODS—Eutectic Welding Alloys Corp., New York City 13. 2-page bulletin describes a complete line of "Low-Temperature" welding rods for salvaging castings. Recommended procedures are given for the repairing of cast iron, malleable iron, bronze casting, aluminum, magnesium and zinc die castings.

25 CUTTING LUBRICANT—Oakite Products, Inc., New York City, 6. 20-page booklet describes a new soluble oil and recommends procedures for its use in cutting, machining, grinding and boring operations on ferrous and non-ferrous metals.

26 MOTOR BRUSHES—The Ohio Carbon Co., Cleveland 11. A pamphlet in folder form lists the many all-purpose motor brushes in the company's No. 35-A kit.

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27 PIPE AND FITTING CHART—Tube Turns, Inc., Louisville 1. Time-saving chart of Pipe and Fitting Materials deals with carbon, intermediate alloy, stainless and spacial-analysis steels for piping and covers welding procedures, ASTM specifications, chemical analyses, service limitations, etc.

28 ELECTRONIC CUTTING—Air Reduction Sales Co., New York City. 12-page pamphlet (reprint from *The Welding Journal*) discusses the economical and time-saving uses of the newly developed electronic tracing device. Sections cover the cutting of stainless steels, practical employment of hot cut-off machines, special mechanical adaptations for cutting in vertical and horizontal positions, plate slitting, trimming and squaring, billet nicking and heavy scrap cutting.

29 ELECTRICAL EQUIPMENT—Electric Specialty Co., Stamford, Conn. 8-page catalog (No. 46-1) describes special motors, generators, motor-generator units, converters and other rotating electrical products. Also included are a-c/d-c, and universal motors for applications not met by standard motors; dynamotors and convertors; motor-generator sets; a-c/d-c generators; gas and Diesel electric generating plants.

30 R-W ALLOYS CHART—Ampco Metal, Inc., Milwaukee. A new two-page chart "Comparative Resistance-Welding Alloys" lists by groups, classes and trade names, copper-based and copper-tungsten alloys produced by eight companies serving the resistance-welding electrode field. RWMA minimum physical properties for each of the three alloy classes given.

31 PRODUCTION CHUCKS—Rayco Mfg. Co., Chicago 15. 4-page bulletin describes a high speed production chuck for drill press and hand power tools. This chuck is said to permit quick tool changes without shutting off the power tool. Illustrations show how these changes are made.

32 TOOL SALVAGING—Eutectic Welding Alloys Corp., New York City 13. 2-page bulleting gives recommended procedures for the production and salvage of working tools. For each of these applications, five different alloys are listed with their respective properties.

33 REMOTE CONTROL—Transicoil Corp., New York City 13. 2-page bulletin illustrates and describes the new "Transicoil," a 60-cycle, 2-phase, low-inertia "Servo-Motor" for remote control applications.

34 POWER TRUCKS—Lewis-Shepard Products, Inc., Watertown 72, Mass. 8-page bulletin in folder form describes the various lift trucks, stackers, power fork trucks, skid platforms and floor trucks for use in all types of industries.

35 WELDING PRECAUTIONS—Air Reduction Sales Co., New York City 17. 24-page pocket-size manual describes the "do's and "dont's" for handling oxy-acetylene and arc-welding equipment. Illustrations show the care to be exercised when using gas cylinders, torches and regulators, hose lines and generators. The prevention of backfires and flashbacks is among the topics covered. Notes on personal safety are also included, and instructions are given for the proper welding of tanks, containers and pipe lines.

36 WELDING MACHINES—Precision Welder and Machine Co., Cincinnati. 4-page booklet describes spot and projection press welders. The text covers AVA (air vertical action) —1, 2 and 3 made in four standard sizes ranging from 30 to 500 kva. A list of specifications for each type concludes the booklet.

37 WORK HOLDERS—McFerron-Meyers Products Co., Cleveland 14. 4-page bulletin describes a new work holder for making angle welds up to 180 deg. The text is interspersed with illustrations of these "Duo-Square" holders in operation and the various models available.

38 R-W ELECTRODES—Ampco Metal, Inc., Milwaukee 4. 20-page bulletin (No. 68-A) describes Ampcoloy resistance-welding electrodes and alloys. Included are diagrams and information covering a new line of water-cooled tips and a list of seam welder wheels and dies for flash-butt and projection welding.

39 AIRLESS CLEANER—American Foundry Equipment Co., Mishawaka, Ind. 24-page catalog (No. 74) describes the "Airless Wheelabrator," an abrasive cleaner for finishing metals and cleaning pipe edges prior to welding. Photographic illustrations show the structure and operation of the unit.

40 PATENT INFORMATION—Invention, Inc., Washington 4, D.C. Pocket-size folder, "Telling the Age of a U.S. Patent by its Number," gives dated tabulation of the numbers for patents, reissues, designs and tradenames for the last 110 years.

41 TEMPERATURE CONTROL—Claud S. Gordon Co., Chicago 16. 4-page color bulletin gives technical description of "Xactline" straight-line temperature control for electric furnaces. This control is said to hold tolerances as close at ½ of a degree F and enable on-off cycles as short as three seconds.

42 HYDRAULIC PRESSES—Air Hydraulics, Inc., Chelsea, Mich. 8-page catalog covers air-hydraulic presses for heat-sealing, forming, flanging; marking, assembly, riveting, broaching and crimping.

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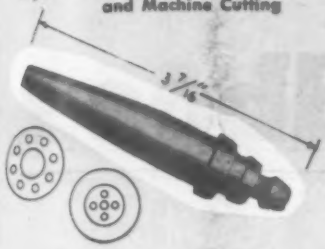
Style 144 — For General Hand and Machine Cutting

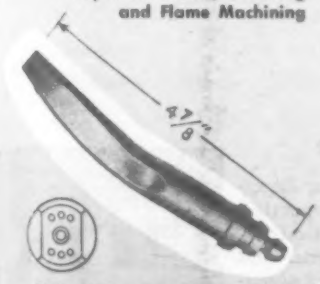


Style 197 — For Rivet Washing

Style 195 — For Hand Cutting of Rivet Heads and Machine Cutting 45° Bevels

Style 181 — For Riser Cutting

Style 183 — Gouging, Removing Imperfect Welds, Grooving and Flame Machining



Style 209 — For General Hand and Machine Cutting with Oxygen and Propane or with Oxygen and Natural Gas

AIRCO SERIES 9000

Here is a sturdily-built, medium-weight torch especially engineered for general purpose cutting. The wide range of tips (a few of which are illustrated), built expressly to speed up cutting operations on many types of jobs, gives unequaled versatility to this torch.

- Forged stainless steel lever (or trigger if preferred) conveniently located.
- Torch handle of ribbed design affords a "sure" gripping surface, with a minimum of fatigue.
- Furnished in various lengths with straight, 45°, 75°, or 90° angle heads.
- Approximate weight of 21-inch standard length torch with tip: 3 lbs. 4 ozs.
- Gas passages are of ample proportions.
- All tube connections are silver brazed to assure permanent leakproof service.
- Gases are mixed for preheating in the tips—not in the torch.

For complete information about this versatile torch, with its full complement of tips, write for Bulletins ADC-617 and ADG-1098. Address: Air Reduction, General Offices, 60 East 42nd Street, New York 17, N.Y. In Texas: Magnolia Airco Gas Products Company, General Offices, Houston 1, Texas. Represented Internationally by Airco Export Corporation.

AIRCO

AIR REDUCTION

Offices in All Principal Cities

HEADQUARTERS FOR OXYGEN, ACETYLENE AND OTHER GASES . . . CARBIDE . . . GAS WELDING AND CUTTING APPARATUS AND SUPPLIES . . . ARC WELDERS, ELECTRODES AND ACCESSORIES

New! A Handbook

METALS WEIGHT CALCULATOR

One of the handiest calculating devices ever developed . . . simple . . . accurate . . . fast. Calculates the weights of aluminum, magnesium, steel, brass, copper, and nickel. Only $.50. Check space in coupon.

ALLOY SELECTOR

Two settings place at your fingertips the mechanical properties, chemical composition, physical constants, thermal treatments, and specification numbers of *18 aluminum alloys*. Only $1.00. Check space in coupon.

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REYNOLDS METALS

REYNOLDS ALUMINUM

The Great New Source of

INGOT · SHEET · SHAPES · WIRE · ROD · BAR · TUBING · PARTS · FORGINGS · CASTINGS · FOIL · POWDER

on Welding Aluminum

Are you welding aluminum now? Do you plan to weld aluminum in the future? If so, this book is for you!

HERE'S A NEW up-to-the-minute book, "Welding Aluminum," that presents a concise, authoritative discussion of problems dealing with welding aluminum and aluminum alloys. Many new war-developed applications are described. Under a single cover, in handy usable form, you will find detailed information on 11 aluminum welding processes, from edge preparation to finishing, a comprehensive discussion of aluminum alloys and tempers, and helpful tables on properties, gauges, sizes, and strengths.

"Welding Aluminum" is clearly illustrated with 44 interesting photographs and graphs of welding operations. If you work with aluminum, you'll find "Welding Aluminum", prepared by the technical staff of the Reynolds Metals Company, an invaluable reference book.

How do you get your copy? Simply fill out the coupon on this page and mail with your check or money order for one dollar to cover the cost of printing and mailing, to Reynolds Metals Company, 2561 South Third Street, Louisville 1, Kentucky.

83 PAGES packed with accurate up-to-the-minute facts, figures, and photographs about

GAS WELDING
- Edge Preparation
- Cleaning and Preheating
- Welding Flame
- Welding Rods
- Welding Fluxes
- Heat-Treatable Alloys
- Aluminum Castings

ARC WELDING
- Metal-Arc Welding
- Carbon-Arc Welding
- Atomic-Hydrogen Arc Welding
- Inert-Gas-Shielded Welding

RESISTANCE WELDING
- Spot Welding
- Seam Welding
- Flash Welding

BRAZING ALUMINUM
- Furnace
- Torch

SOLDERING ALUMINUM

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Please send me "Welding Aluminum." I enclose $1.00 (check or money order) to cover the cost of printing and mailing.

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

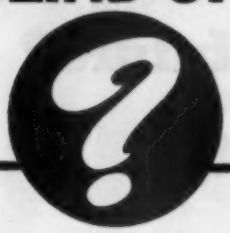
CITY _____ ZONE ____ STATE _____

( ) Please send me a Reynolds Weight Calculator. I enclose 50 cents.

( ) Please send me a Reynolds Aluminum Alloy Selector. I enclose $1.00.

PLEASE TYPE OR PRINT CAREFULLY

WHAT IS *YOUR* BUSINESS "BLIND SPOT"



Business activity is running at flood-tide! Authorities say the greatest era of expansion ever known is just ahead. Right now—today—there are more top-flight positions than there are men capable of filling them.

And here's the reason why: Responsible, high-salaried jobs demand men who are familiar with the whole structure of business—Accounting, Finance, Production and Marketing. Men with "blind spots"—those whose knowledge is limited to one or two departments—are severely handicapped.

Since 1909, the Alexander Hamilton Institute has enabled more than 430,000 men to overcome their deficiencies in essential business knowledge.

The Institute's program of executive training is described in the fast-reading pages of "Forging Ahead in Business." You may have a copy of this stimulating 64-page booklet, free and without obligation, simply by returning the coupon below. But please do not send for the booklet unless you are genuinely interested in self-improvement. Its appeal is limited to men who are looking ahead and who seriously intend to move ahead. For men of that type, "Forging Ahead in Business" has an inspiring and informative message.

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Please mail me, without cost, a copy of the 64-page book —"FORGING AHEAD IN BUSINESS."

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Position.....
Home Address.....

News of the Industry

HomeOla Corp. to Build 19,400 Steel-Framed Homes

COMPLETED negotiations between the Government and HomeOla Corp., Chicago, clear the track for the erection of 19,400 prefabricated homes to be built by the end of 1947. Prediction of this project, written under the Veterans Emergency Housing Act, will begin at a rate of ten homes per day, rising to 100 a day by next June. Agreements with at least two other producers are nearly completed, but the big deals for aluminum houses from wartime airplane assembly lines are still in the preliminary stages.

The HomeOla house is framed by steel beams bolted to steel plates that rest on concrete foundations. Steel trusses are used for the one-story model because of its larger ceiling and roof area. Overall dimensions of the one-story model are 24 by 32 ft and the story-and-a-half model is 20 by 24 ft.

As shipped from the factory, these new houses will include plumbing fixtures, heating unit (oil, coal or gas), electric or gas hot water tank, electrical fixtures, plywood kitchen cabinets and double compartment sink. Initial costs are expected to average around $5,400 for the story-and-a-half six-room house and $6,400 for the single-story house, owner erected. The erector provides grading and foundation, painting, glass and glazing, roof shingles, range and refrigerator. The prices given do not include settlement and brokerage fees.

* *

Install First Aluminum Bridge

CLIMAXING fifty years of study and research on the uses of aluminum for bridge construction, an all-aluminum bridge span has been installed on the new Grasse River bridge of the Massena Terminal Railroad, Massena, New York. The 100-ft. span is built entirely of aluminum alloys and weighs only 53,000 lb as compared to 128,000 lb for similar steel spans. It was fabricated by the Bethlehem Steel Co., at Rankin, Pa., and designed by the Aluminum Co., of American with the firm of Hardesty and Hanover acting as consultant.

* *

Demonstrate Ingersoll Fabricated Home Units

INGERSOLL village, consisting of 12 demonstration houses designed around the new Ingersoll Utility Unit, was opened to the press last month at Kalamazoo, Mich. The houses were designed by the Ingersoll Steel Division, Borg-Warner Corp., and were under construction and test for months while Ingersoll engineers satisfied themselves that the new "heart of the home" measured up to its drawing board concept.

The Ingersoll Utility unit (fully described in THE WELDING ENGINEER for April, 1946) is a factory-fabricated central core containing the homes' furnace, water heater, plumbing vents and stacks, electrical connections and controls. All the plumbing, pipe lines, electrical wiring, heating, hot water and lighting elements are shaped, fitted and put into a steel framework on an assembly line at the factory.

* *

A. M. Morris Made Publisher of WELDING ENGINEER

ARCH M. MORRIS, formerly general manager of THE WELDING ENGINEER, *Welding Encyclopedia* and *Mill Supplies* magazine, has been appointed publisher of these three McGraw-Hill publications upon the recommendation of N. O. Wynkoop, former publisher. Mr. Morris joined McGraw-Hill in 1928 as sales manager of *Industrial Distributor and Salesman.* During the following spring when the company acquired *Mill Supplies* and combined it with I.D. & S, Mr. Morris was made general manager of the combined publication under the name of Mill Supplies.

In 1933 Mr. Morris left McGraw-Hill to explore a venture of his own but returned in 1938 to take a place on the sales staff of *Engineering News-Record.* In 1940 he was made manager of *Mill Supplies.* With the purchase of THE WELDING ENGINEER and *Welding Encyclopedia* from Mrs. G. H. Mackenzie in the fall of 1945, Mr. Morris was given the additional position of general manager of these two publications.

* *

Lincoln Directs Arc-Welding Film

"DESIGN For Arc-Welded Structures," a new 16-mm motion picture produced by Herb Lamb Productions and directed by The Lincoln Electric Co., uses both color and sound to visualize the improvements in design and construction made possible by arc welding. This 15-minute movie humorously portrays a cave man's first attempt to join a structure with thongs and reviews the development of fastening methods . . . wooden pegs, nails and so on to the development of arc welding. Prints are available from The Lincoln Electric Co., without charge.

Replace with RCA IGNITRONS

RCA-5550 (Size A)
Directly interchangeable with GL415 & WL651/686
RCA-5552 (Size C)
Directly interchangeable with FG235A & WL651/656
RCA-5551 (Size B)
Directly interchangeable with FG271 & WL652/687
RCA-5553 (Size D)
Directly interchangeable with FG258A & WL655/658

- For Welding Control
- Power Conversion
- Power Rectification

Directly interchangeable with other standard types

RCA Ignitrons fill major renewal requirements and are directly interchangeable with types commonly used in welding-control units, power conversion equipment, and power rectifiers.

The RCA Ignitrons illustrated are representative of a large and growing family of RCA industrial electron tubes of which there are over 200 *standard* types. Included in this group is a complete line of thyratrons, power amplifiers for high-frequency heating equipment, and an equally complete line of high-vacuum and mercury-vapor rectifiers for low- and high-voltage applications.

RCA industrial electron tubes embody the ruggedness, high quality and long service life which you should expect from tubes designed specifically for continuous duty applications. They can be counted on to deliver outstanding performance.

When you need renewal tubes, look to RCA.

SEND FOR BULLETIN GIVING COMPLETE DATA

Bulletin No. 2F237 covers prices, technical description and interchangeability by type numbers of the complete line of RCA industrial electron tubes. A request on your company letterhead addressed to RCA, Commercial Engineering, Section IR-33K, Harrison, N. J., will bring your copy.

RCA LABORATORIES
PRINCETON, N. J.

IN RADIO AND ELECTRONICS—THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

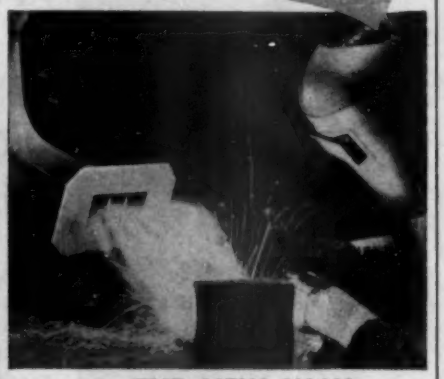
TUBE DEPARTMENT

RADIO CORPORATION of AMERICA

HARRISON, N. J.

Why the RUEMELIN FUME COLLECTOR *is a* REAL NECESSITY

● *THE OLD WAY*



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PENNSYLVANIA RAILROAD
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SINCLAIR REFINING COMPANY
INLAND STEEL CORP.
OLIVER IRON MINING CO.
NATIONAL LEAD COMPANY
MASSEY HARRIS COMPANY
MARQUETTE CEMENT MFG. CO.
MAYNARD ELECTRIC STEEL CASTING CO.

PATENTED

TWO MODELS!

- Long reach Model D-5342 — ideal for large welding booths; reaches out 15 feet from wall.
- Standard Model D-5310—used for standard welding booth ventilation; hood reaches out 9 feet from wall.

The Ruemelin Welding Fume Collector has been specially engineered to eliminate noxious fumes. The inlet hood maintains a constant high velocity over the working area, quickly removing heat and smoke *at the source*. Welders equipped with this device are assured of a clean shop atmosphere; the manufacturer gains by increased daily production.

The fume collector hood can be instantly placed where needed anywhere in the booth welding area. No tedious adjustment necessary. Just pull the inlet hood to the welding position and you are ready to go. Approved by state industrial commissions and by compensation insurance companies. Many users send in repeat orders. Write for bulletin 37-C today.

RUEMELIN MANUFACTURING CO.

3880 N. PALMER ST. • MILWAUKEE 12, WISCONSIN

Manufacturers and Engineers of Sand Blast and Dust Collecting Equipment

German Rods Resist Hot Cracking Tests

GERMAN tank armor seams welded with austenitic electrodes were capable of resisting hot cracking tests, according to a 56-page report written by Major L. F. Denaro, British Royal Engineers, for the Combined Intelligence Objectives Sub-Committee. Major Denaro attributes the German's success with austenitic rods to a higher manganese content. The rod used contains about 18% chromium, 8% nickel and 6% manganese.

The Germans also developed a ferritic electrode with very good properties by concentrating on basic lime fluorspar coatings. This "R.N.D." electrode, containing a minimum of chromium, nickel, manganese and other scarce materials, became the standard for Nazi tank construction.

Orders for the report (German Research in Tank Armor Welding; PB-27055; photostat, $4; microfilm, $2) should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D.C., accompanied by check or money order payable to the Treasurer of the United States.

* *

$1,315,794 Paid for Welded Tubing Plant

THE BABCOCK & WILCOX CO. has purchased from the War Assets Administration for $1,315,794 the welded boiler tubing plant at Alliance Ohio. Built and operated by the company in 1942 at the request of the government, it was scheduled to produce 4,000 tons of ¾ to 4 in. welded tubing each month.

* *

Electrical Show Draws Widespread Interest

A great number of exhibitors have already enrolled for the Electrical Engineering Exposition to be held in New York City's 71st Regiment Armory, January 27 to 31. The show will be held in conjunction with the winter convention of the American Institute of Electrical Engineers.

MORE of EVERYTHING a WELDER WANTS in Arc-welding Equipment

Copyright 1946, General Electric Co.

Welder's gloves

Ventilated helmet

300-amp a-c welder

Single-operator, portable d-c welder, 300-amp model

SETS—A-c and D-c . . .

. . . with special controls and operating features that make better welding easier—indoor or outdoor, 100 to 1000 amps. Inert-Arc and Atomic-hydrogen welding equipment, engine-driven sets, and automatic machine-welders are also included in the G-E line.

ELECTRODES

Headed by the *new* W-20 general-purpose electrode (this single electrode meets 60% of industry requirements), the G-E line-up includes general and special-purpose rods, production-tested and -labeled, for almost any metal or application—and all *available for immediate delivery*. Why not sample a few?

ACCESSORIES

Twenty-four to 48-hour service is available on orders for most G-E accessory items—all built for added protection and longer life. One of the most complete lines available, it includes ventilated helmets and hand-shields, electrode holders, protective clothing of all types, and Strike-easy and weld-spatter-resistant compounds.

Your nearest G-E Arc-welding Distributor is waiting to service your welding requirements. See him, 'phone him, or write him! *Apparatus Dept., General Electric, Schenectady 5, N. Y.*

Armored electrode holder

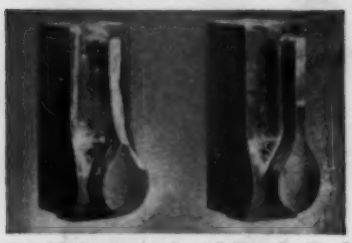
VISIT US AT THE NATIONAL METALS SHOW

Coming to the National Metal Congress and Exposition in Atlantic City November 18 to 22? If so, be sure to plan on a visit to the G-E Welding Booth. You'll find the several operating exhibits (Inert-Arc welding of aluminum, newest techniques and developments with the latest type electrodes, etc.) mighty interesting.

GENERAL ELECTRIC

673-75-6748

The Pioneers of Tool and Die
WELDING ELECTRODES
Can Effect Savings in Your Plant!



Die Unit repaired with Eureka Tool and Die Welding Electrodes. No heat treatment required.

Compositely Constructed Die Unit using Eureka Tool and Die Welding Electrodes. No heat treatment required.

You can save many man hours, conserve material and minimize production delays. Tool steel welding can be used profitably in any plant using tools and dies. Here's how it can be done:

1 *REPAIRING DIES* . . . Existing units that may fail in operation can be welded, either partially or wholly, resulting in a minimum of "down-time".

2 *COMPOSITE FABRICATING* . . . Die units can be compositely fabricated, when practical, by welding, resulting in numerous advantages.

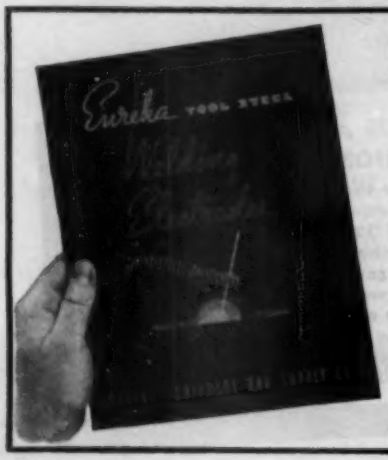
4 *RECTIFYING ERRORS* . . . Welding permits the correction of errors made in tool and die manufacturing resulting in great savings.

For complete information write for technical catalog

Eureka Welding Equipment & Supply Co.

PIONEERS IN TOOL AND DIE WELDING ELECTRODES

223 LEIB STREET • FITZROY 3715 • DETROIT 7, MICHIGAN



FREE *Just clip and mail the coupon below for your free copy of our latest 40-page illustrated booklet, which will help you save many valuable man hours and minimize production delays.*

WELDING EQUIPMENT & SUPPLY CO.
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DETROIT 7, MICHIGAN

Rush me your catalog:

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ASME Elects New Officers

EUGENE W. O'BRIEN, vice-president of the W. R. C. Smith Publishing Co., Atlanta, Ga., was named president of the American Society of Mechanical Engineers as a result of letter balloting by 21,000 members. Regional vice-presidents elected are: Professor Linn Helander, head of the department of mechanical engineering, Kansas State College; Thomas S. McEwan, vice-president of McClure, Hadden and Ortman, Inc., Chicago; Albert R. Mumford, development engineer of Combustion Engineering Co., New York City; Edward E. Williams, general superintendent of steam plants for Duke Power Co., Charlotte, N. C., and Alton C. Chick, assistant vice-president of Manufacturers' Mutual Fire Insurance Co., Providence, R. I. Directors at large are: Frederick S. Blackall, Jr., president and treasurer of Taft-Pierce Manufacturing Co., Woonsocket, R. I.; Wilber A. Carter, technical engineer of power plants, Detroit Edison Co.; and Lewis F. Moody, professor of hydraulic engineering at Princeton University.

* *

Offer New Methods to Test Pipe Lines

SAM TOUR & CO., INC., New York City firm of engineers, metallurgists and consultants, has extended its facilities for the non-destructive testing of pipe lines, ship hulls, pressure vessels, etc. with two new warborn instruments called the "Penetron" and the "Probolog." Dismantling of equipment and the destructive drilling of test holes can be minimized with these new instruments, the company asserts. Alexander Gobus, vice-president, has been placed in charge of the new Sam Tour service.

* *

Niles Welding Opens New Branch Plant

THE Niles Welding & Machine Co., Warren, O., is opening a new branch assembly plant on Parkman Road which will provide 11,000 additional square feet of floor space.

"Jorgensen"
CLAMPS

Extra quality—A large variety to choose from
STEEL BAR CLAMPS
CARRIAGE CLAMPS
SPECIAL WELDERS
C CLAMPS
HANDSCREWS
Ask for them by name
Send for Catalog No. 16
ADJUSTABLE CLAMP CO.
"The Clamp Folks"
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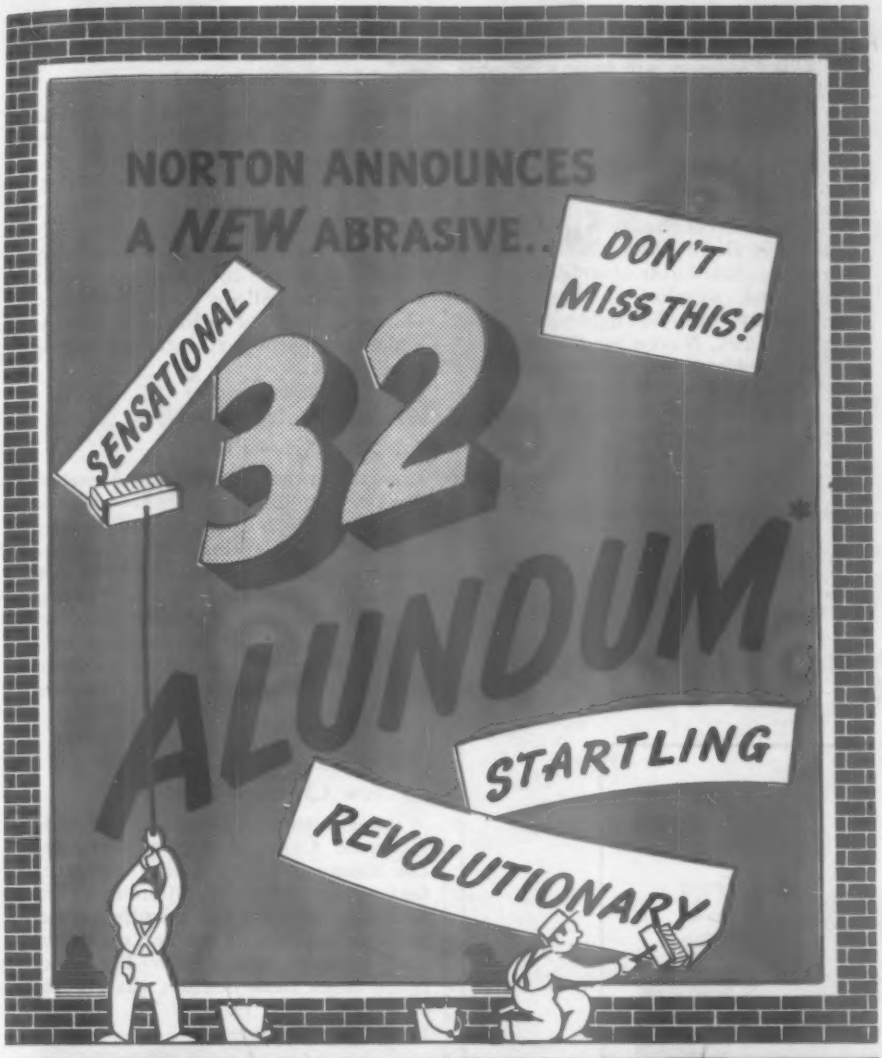

FEATURES OF 32 ALUNDUM*

It is an entirely new type of aluminum oxide abrasive — made differently by a Norton-invented and patented process. Each super-cutting grain is a single crystal — individually produced in the electric furnace — not crushed to size. Each crystal combines a sharp, nubbly surface for fast cutting with a strong grain structure for long life.

BEING New Englanders we're usually pretty conservative in our advertising messages. But here's a new abrasive so radically different, so outstanding in performance, that it really needs Hollywood adjectives to do it justice.

In test after test in the field 32 ALUNDUM* grinding wheels have been truly sensational. They cut faster, cut cooler, last longer and require fewer dressings.

Your production man will want to take advantage of 32 ALUNDUM*.

NORTON COMPANY, WORCESTER 6, MASS.
(The Behr-Manning Division is at Troy, N. Y.)

NORTON ABRASIVES

* T.M. REG. U.S. PAT. OFF.

W-1080A

Especially Effective for Weld Grinding

BECAUSE the grains of 32 ALUNDUM abrasive are *sharper* than those of any other abrasive these new wheels penetrate the work more easily—removing metal faster and with longer wheel life.

This sharper cutting action is especially advantageous with portable grinders where only limited pressures can be applied. Operators find that *much less effort* is required to do more work with 32 ALUNDUM wheels.

Used with the new Norton B-5 and B-7 resinoid bonds, 32 ALUNDUM wheels are showing sensational results on many weld grinding jobs. In one plant, for example, wheel life was increased *three times*—cutting wheel cost per day from $3.38 to $1.29.

Suggested "32" Specifications:

Straight Wheels	32A16-S4B7
Cup Wheels	32A16-R4B7

Ask your Norton abrasive engineer to give you a Vectograph demonstration of 32 ALUNDUM abrasive.

Allis-Chalmers to Build Gas-Turbine Locomotive

UTILIZING much the same principles as are employed for modern jet aircraft America's first gas-turbine locomotive will be placed on the rails sometime within two years. The new iron horse will be a coal-burning locomotive, using powdered coal as the fuel, with an electric drive. It will need no water since the energy of the coal will not be converted into steam. To be built by Allis-Chalmers Mfg. Co., Milwaukee, and the Elliott Co., Jeanette, Pa., the new gas-turbine power units will be developed under the direction of Bituminous Coal Research, Inc., Pittsburgh. The turbine being built by Allis-Chalmers will have a capacity of 3,750 hp.

* *

Welding Distributors to Meet November 8-9

DUE to current business trends and policies in the welding industry affecting every distributor of welding equipment and supplies, a special fall convention will be held in Cedar Rapids, Iowa, November 8 and 9.

Non-members are invited to attend and should write NWSA headquarters at 324 E. Second Street, Dayton, for hotel accommodations.

You Need The —

DISTRIBUTOR!

SERVICE and DEPENDABILITY

When you need industrial supplies, call

Your Local Industrial Distributor

Industry's "Service of Supply"

Write Today for free copy of the booklet:

"Service and Dependability"

Things you should know about Distributors' Services

Mill Supplies

THE MARKETING OF INDUSTRIAL DISTRIBUTION

330 WEST 42ND STREET • NEW YORK 18, N.Y.

Governor Firm Buys Rights to "Servo" Line

PRODUCTION rights, tools and inventory of the centrifugal governor section of the King-Seeley Corp., Ann Arbor, Mich., have been purchased by the Pierce Governor Co., Inc., Anderson, Indiana. The Servo governor will continue to be produced under that name at the Indiana plant. Future plans call for the consolidation of Pierce and Servo lines in order to make some of the parts interchangeable.

* *

Amsco Begins Work on New Niles Plant

CONSTRUCTION has begun on American Brake Shoe Company's new plant in Niles, O., which is expected to be completed by next spring. The L-shaped plant will cover an area of 35,000 sq ft and will be operated by the National Bearing Division of Brake Shoe for the manufacture of bronze-back babbitt lined car journals for use on steam railroad cars and locomotive tenders.

* *

Wall Chemicals Moves to New Chicago Factory

WALL CHEMICALS DIVISION of Liquid Carbonic Corp., has just completed the construction of a new one-story factory at 1454 W. Randolph St., Chicago, built for the manufacture of welding and cutting torches, regulators and welding equipment. The floor space more than doubles that of the company's old factory on Jackson Blvd., in Chicago.

* *

St. John X-Ray Moves

AFTER being located in Long Island City for over 20 years, the St. John X-Ray Laboratory has moved its facilities to Califon, New Jersey, halfway between New York and Philadelphia. The new building is a two-story converted barn.

"Expansion and contraction? Sure, but aren't you giving it too much?"

THE NEWEST CONTRIBUTION TO FASTER, LOWER COST METAL JOINING...

EASY-FLO 45 and EASY-FLO 35

These new silver brazing alloys—Easy-Flo 45 and 35—offer new low brazing temperatures and new low silver contents, features that make possible the faster production of strong, ductile, leak-tight joints and lower costs on a wide variety of metal joining operations.

They have been created by Handy & Harman, originators of the well known silver brazing alloys, SIL-FOS and EASY-FLO. They are offered to industry now as a timely contribution to help lick two big problems—to increase production . . . and to decrease costs.

What will these New Alloys do for you?

AT THE METAL SHOW BOOTH F-147

See EASY-FLO 45 and 35 at work on actual production jobs. Examine the large collection of parts and products now made with low-temperature silver alloy brazing. See how others use fast handling and heating methods to boost production. Discuss your metal joining problems with our field engineers who will be on duty at all times. If you attend be sure to stop at Booth F-147.

—THAT'S THE QUESTION

We can tell you how lower flow point, lower silver content, faster spreading action and small amount of alloy save time and reduce costs. We can tell too, of tests that have won wide approval for these new alloys in the field. But if you want quick action, if you want to start saving and speeding-up NOW, try EASY-FLO 45 and 35 on your own work in your own plant. Ask your regular supplier for a free demonstration . . . or better still if you are familiar with this metal joining method place a trial order with him and put these alloys to your own tests on actual jobs.

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with Full Heat
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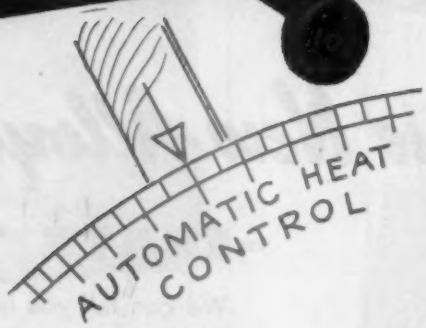
Control and
6 Point Recorder



FOR PRECISION
CONTROL OF
HEAT!

INDUCTION HEATING by the SMITH DOLAN SYSTEM
Plus The New HEAT CYCLE PROGRAM CONTROL
Gives all this and more.—Precision control of PREHEATING
FOR WELDING and NORMALIZING AFTER WELDING
is the only efficient method for joining modern alloy steels.

MODERN — SELF-OPERATING — COMPLETE!

Once the metallurgical heat-cycle for the steel has been determined, it is only necessary to set the controls, and the machine shown above will deliver this program from start to finish! In addition, recorded charts keep permanent records for duplication of results. A complete unit for efficient performance. Temperatures up to 1750° F. readily obtainable.

ELECTRIC ARC, Inc.
152-158 Jelliff Ave. Newark 8, New Jersey

Western Metal Show Scheduled March 22-28

After a six year lapse occasioned by the war, the Western Metal Congress and Exposition will be held in the San Francisco-Oakland Golden Gate area for six days beginning March 22, 1947. W. H. Eisenman, managing director of the show, stated that the two Oakland Civic auditoriums will be needed to house the many exhibits and anticipated attendance of over 50,000. The show is sponsored by the American Society for Metals.

* *

Allegheny Steel Forms New Service Division

Allegheny Ludlum Steel Corp. has consolidated its sales development and engineering service divisions under the managership of W. B. Pierce. Special attention will be given to the developments of new markets for the introduction of new alloys.

* *

Sutton-Garten Co. Opens Ft. Wayne Branch Office

The Sutton-Garten Company, welding distributor of a complete line of welding equipment, recently opened a new sales room and warehouse at 1701 S. Harrison Street, Ft. Wayne, Ind.

Russell F. McNutt, who has been in the welding industry for over twenty years, has been appointed manager of the new branch office.

* *

Wallace Supplies Opens Tube Warehouse Facilities

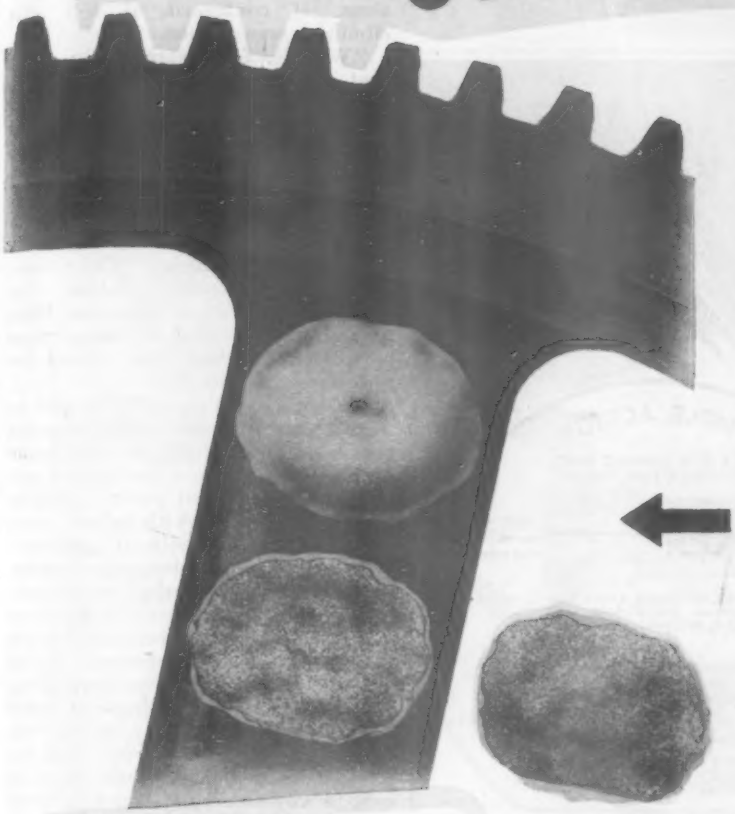
Wallace Supplies Mfg. Co., Chicago has opened a wholly owned subsidiary, Wallace Tube Co., for distribution of various types of industrial tubing and fittings. The new company will carry warehouse tubing as distributors for: Bethlehem Steel Co.; Pittsburgh Steel Co.; Globe Steel Co.; Agaloy Tubing Co.; Lock Joint Tube Co.; and Palmer Appliance Co. In announcing the new subsidiary, Wallace now offers a three-pronged service to industry: (1) bending machines; (2) bending service; and (3) the tubing commonly used in bent form for the manufacture of a range of items from boilers to bicycles.

* *

Brooklyn Polytechnic Has New Engineering Curriculum

To make available to graduate engineers a broad knowledge of the principles of mechanics, the Polytechnic Institute of Brooklyn announces a new curriculum leading to the degree of Master of Science in Applied Mechanics. These studies are incorporated in the expanded department of aeronautical engineering headed by Professor R. P. Harrington. The new engineering curriculum is open to young graduates of engineering colleges as well as to men who have had years of practical experience in some field of engineering.

Stronger BRONZE WELDS ON CAST IRON



"PETERSON" FLUX ASSURES STRONGEST BOND KNOWN TO BRONZE WELDING—WITH FAST CLEANING ACTION

Using PETERSON No. 3 Special Low Heat Flux, these two bronze buttons were welded to this rusty, greasy gear casting without first grinding or chipping.

PETERSON Flux was wiped over a heated red spot the size of a quarter; then the flame was played over the spot until the scale and oxide were washed off to the side.

Melted bronze was dropped onto the spot where it flowed and penetrated into the pores of the cast iron like water dropped onto a blotter. Bronze was added until the button was ¼ inch high.

Bronze button was knocked off with a chisel held at 30 degree angle. NOTICE LARGE CHUNK OF CAST IRON PULLED AWAY WITH THE BRONZE BUTTON, PROVING THE BOND.

PETERSON FLUXES OF MERIT

No. 1 BLUE—for brazing steel, malleable, clean cast iron. For welding brass, bronze and copper.

No 2. HIGH HEAT — for brazing cast iron at medium and high heat.

No. 3 SPECIAL LOW HEAT — for brazing cast iron at low and medium heat.

No. 5 CAST — for welding cast iron without pinholes or hard spots. Leaves a soft machineable weld.

OTHER PETERSON PRODUCTS

Kerosene Preheaters — Portable 12 gallon tank with two burners.

PETERSON SURFACE GRINDERS for resurfacing cylinder heads, blocks and flat castings. No set-up required. Average warped cylinder head ground true in five minutes,

PETERSON WELDING LABORATORIES

1423 VIRGINIA AVENUE — KANSAS CITY 6, MISSOURI

G-E Opens Houston Welding Branch

To give improved service to the welding industry of Texas, the General Electric welding division recently opened a branch office in Houston. Facilities are available for demonstrating welding processes and techniques, and a completely equipped service and repair shop is maintained.

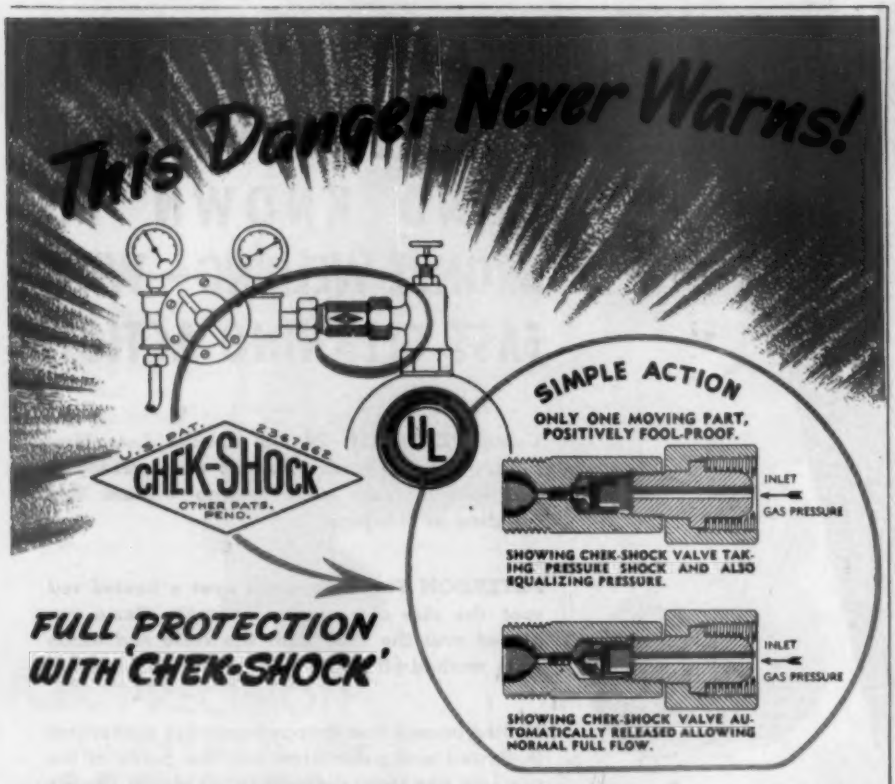
* *

Develop New Method for Processing Rounds

WORKING in collaboration, the Jessop Steel Co., Washington, Pa., and the Barium Steel and Forge Co., Inc., Canton, O., have developed a new method of processing high-speed-steel rounds in diameters greater than 4 in. The process, known as "Vee-Oginizing," is said to assure a uniform carbide distribution and eliminate brittle carbide patterns.

* *

THE board of trustees of Drexel Institute of Technology has appointed an advisory committee on metallurgical engineering and the immediate introduction of courses in metallurgical engineering. The new courses will lead to degrees of bachelor and master of metallurgical engineering not previously granted at Drexel.



CHEK-SHOCK OXYGEN CUSHION VALVE

SOFTLY controls the vicious "jolt" of high pressure oxygen gas, thus eliminating regulator repairs and preventing possible injury to operators.

- Will allow tank valve to be opened rapidly without damage to regulator or danger to operator.
- Will increase life of regulator assembly.
- Will eliminate possible injury to operator from burstings.
- Will prevent unnecessary internal wear in regulator *(as NOT necessary to release control screw before opening tank valve).*

This PROVEN automatic safety device cushions the initial "blast" of pressure when tank valve is turned on (this uncontrolled surge which strikes like a hammer is the direct cause of most damaged regulators and accidents), when pressure slowly bleeds and equalizes then CHEK-SHOCK allows a full flow of oxygen.

PRICE IS LESS THAN ONE REPAIR BILL

#1. STANDARD COUPLER—for all standard size welding type oxygen regulators.
#2. LIGHT COUPLER—for "airplane" or soldering size oxygen regulators.
#3. HEAVY DUTY COUPLER—recommended for extra heavy duty work only.
#4. SCREW TYPE COUPLER—for removable inlet stem regulators (¼" pipe) available in standard, light, or heavy capacities. $6.00 ea.
#5. FOR HYDROGEN—left hand thread coupler. We also make Medical Chek-Shocks for all types of medical regulators and tank fittings (chrome plated).....$7.00 each

SEE YOUR DISTRIBUTOR OR WRITE

Chek-Shock MFG. CO.
FOWLER CALIF.

Letter to the Editor

"ARC welding has produced a record for reliability in billions of welds, yet it is being attacked in a way which is tremendously handicapping its application and promises still more to interfere with its future use. This attack consists in throwing suspicion on the process by writing into specifications expensive and impractical tests which have little to do with the excellence of the weld. Most of them have to do with infinitesimal variations of no possible importance but of great cost. The attack has already eliminated the economic use in many proper applications. If continued, it will soon eliminate many others.

"We see, for instance, the ruling that certain welds must be X-rayed, which increases the cost by several times, yet the commercially welded joint is always of greater strength than the parent metal and is tremendously stronger than any riveted joint, where X-raying never has been suggested.

"We see riveted joints which are made tight by caulking. This process is accepted without question. The resulting undercut is enormous, while a welding undercut that is infinitesimal is frequently made the reason for rejection of welds.

"We see welds chipped out and rewelded and welded vessels rejected because of trifling defects such as infinitesimal porosity either on the surface or beneath, yet parent metal in the same structure with defects much greater is accepted without question.

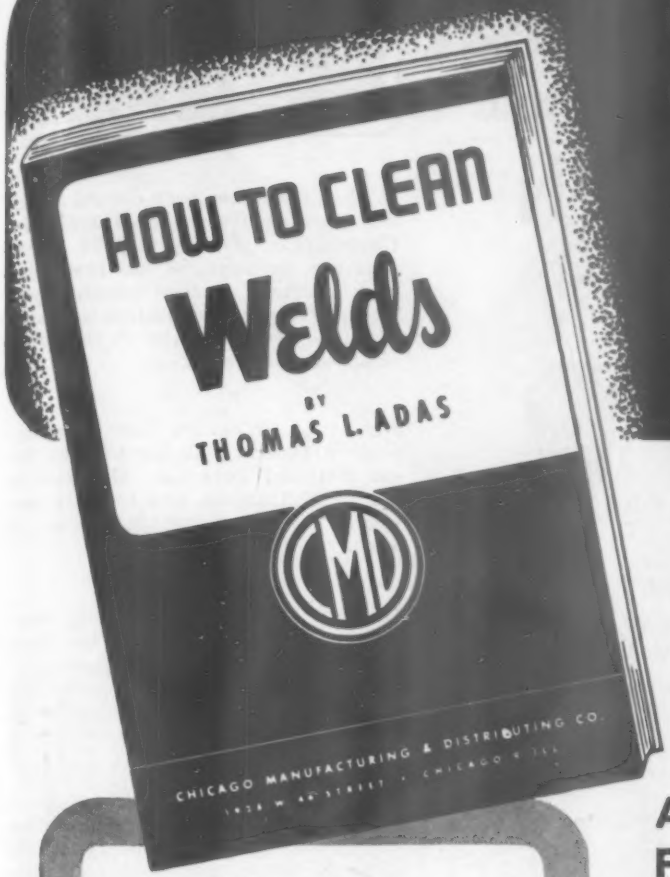
"We see welding electrode specifications being written that enormously increase the cost of production with no increase in either the reliability nor in the excellence of electrodes. Rivets have no such test to handicap them. While the welding electrode is tested in every conceivable way, no one suggests any test on a rivet. Yet the riveted joint is always the weakest spot in any structure, which is never true of a full-sized welded joint.

"Much time and money go to test the electrode deposit to make sure it has great ductility, but riveted joints have no elongation and are accepted without question. The contour of the deposit of a weld is a matter of very close inspection, yet no one examines the contour of any rivet or the hole it only partially fills. Nor does anyone X-ray a riveted joint and reject it because of the voids between the rivets and rivet holes.

"It is time we dealt with reality. Welding over the years has done a more reliable job than the rivets it has replaced. That record is conclusive. The engineering profession must recognize and resist this studied attempt to eliminate the arc welding process. The success of such an attack on this tremendously valuable method is neither good advertising for the engineering profession nor good ethics."

J. F. LINCOLN (signed).
President, The Lincoln Electric Co

This NEW FREE Booklet



WILL HELP YOU

- Improve Workmanship
- Increase Production
- Reduce Costs

AUTHENTIC INFORMATION FOR EXPERIENCED WELDORS AS WELL AS BEGINNERS

"How to Clean Welds" will help you teach apprentices the *right methods first*, and give experienced weldors welcome suggestions on short-cuts that save their time. It will help you prevent mistakes that waste metal and require rewelding and consequent delays. Send for a copy today!

16 DATA-PACKED PAGES *On All Phases of Weld Cleaning*

1. **Importance of Weld Cleaning.** Harmful effects of dirty welds.
2. **Methods of Cleaning Welds.** Hammer and brush grinding, chemicals.
3. **How to Clean Arc and Gas Welds.** Ferrous, Non-ferrous, bronze, light metals.
4. **Tests of a Clean Weld.** Visual, chemical.
5. **Cleaning Before, During, and After Welding.** New and old techniques.
6. **Effect of Rust, Oil, and Dirt on Welds.** Importance of pre-weld cleaning.
7. **Cleaning Subsequent Beads, Fillets, Grooves.** The right way to handle these operations to thoroughly remove slag.

Mail Coupon NOW!

Chicago Manufacturing & Distributing Co.
1928 West 46th Street, Chicago 9, Illinois

Please send (.....) copies of "How to Clean Welds."

Name .....

Firm Name .....

Address ..... State .....

City .....

Clean Welds Mean Sound Welds - Lasting Satisfaction

PRODUCTION UP- COSTS DOWN

PROFIT POSSIBILITIES in any job shop or on any production line depend on higher output at lower cost.

G-R offers this "ideal combination" with:

● **FASTER WELDING...** because magnetic blow is eliminated with G-R's smooth a. c. arc current. Thus you can use higher heat with faster burn-off, which means higher rate of deposit ... *more welding done every hour!*

● **LOWER COSTS...** because up to 94.6% of the power consumed is available as usable welding current with a G-R... nearly twice the efficiency of d. c. motor generator sets!

Step up production with A. C. welding... and for A. C. at its best, specify **G-R!**

G-R Model 35, with a welding range of 15 to 330 amperes, heads the G-R line of five "General Purpose" welder models, starting with the 10-100 ampere Model 10C. All are available with built-in power factor correction.

The 10- to 675-ampere Model 49 is one of four G-R Heavy Duty Industrial Models for manual operation. G-R also builds heavy-duty models for automatic-head welding, to 2,500 amperes.

GLENN-ROBERTS
COMPANY
2107 ADAMS STREET • INDIANAPOLIS 1, INDIANA
3100 E. TENTH STREET • OAKLAND 1, CALIFORNIA

About People

C. M. TAYLOR has been elected executive vice-president of the The Lincoln Electric Co. During his 28 years with the company, he has been foreman, assistant superintendent, superintendent and vice-president in charge of sales. He has served on the board of directors since 1927.

* *

HENRY J. WALLACE has been appointed general manager of sales for the National Tube Co. He succeeds W. F. MCCONNON who recently was elected vice-president in charge of sales.

* *

HAROLD N. EWERTZ, formerly sales manager for Arcos Corp., has been named sales manager of McKay Company's electrode division. Mr. Ewertz brings to his new position a broad background of welding experience.

* *

HARRY A. SUTTON, formerly director of engineering for Consolidated-Vultee Aircraft Corp., has been appointed assistant to the president and engineering advisor to the Ryan Aeronautical Co.

* *

WESLEY N. GORDON has been appointed manager of the alloy sales division in the general sales department of U.S. Steel Supply Co. He will have jurisdiction over alloy sales in Boston, Newark, Baltimore, Pittsburgh, Cleveland, St. Paul, Milwaukee, St. Louis and Chicago, with headquarters in the last named city.

* *

HAROLD E. PIGGOTT has been promoted to general manager of the Dockson Corp., Detroit, and placed in charge of sales, manufacture and active management of the company's entire activities.

* *

RUSSELL J. LOVE, formerly chief engineer for Southwest Welding and Manufacturing Co., Alhambra, Calif., has been elected executive secretary of the Pressure Vessel Research Committee of The Welding Research Council. The committee has established its headquarters at 30 Church Street, New York City 7.

* *

E. A. TICE, formerly corrosion engineer in the research department of Bethlehem Steel Co., has accepted the same position with the corrosion engineering section of the development and research division of International Nickel Co., Inc.

SO EASY TO APPLY..
it almost runs itself!

*For HARDFACING all wearing equipment where *Impact* and *Abrasion* are involved.

NEW EXTRUDED COATING
improves application and welding characteristics of
STOODY SELF-HARDENING*

FROM ALL OVER THE NATION come enthusiastic reports on ease and speed of applying the new Extrusion COATED STOODY SELF-HARDENING! This harder, more uniform coating brings improved welding performance: Slashes welding time, assures dense deposits, minimizes porosity!

NO MORE TEDIOUS SCALING—where multiple passes are required, slag is easily removed while deposits are still hot—*is SELF-LIFTING as deposits cool!*

AC-DC APPLICATION—use either type machine. Amperage adjustment isn't fussy . . . good arc characteristics over a wide range! Can be deposited in any bead type or welded in any position.

NO CHANGE IN PHYSICAL CHARACTERISTICS—you get the same high wear resistance, same hardness—even on multiple passes!

GIVE THE NEW COATED STOODY SELF-HARDENING A WHIRL. You'll *like* the way it handles, you'll grin with satisfaction at results . . . for it's the same wear resistant metal that's won and held its place on merit for 20 years . . . now improved for easier, faster welding!

600 Distributors can supply you. Choice of 1/8", 5/32", 3/16" and 1/4" diameters. No change in price!

STOODY COMPANY
1146 W. SLAUSON AVE., WHITTIER, CALIF.

STOODY HARD-FACING ALLOYS
Retard Wear — Save Repair

GET THE MOST from your hardfacing dollar

Write for free "STOODY HARDFACING GUIDEBOOK" A book by welders on proven hardfacing techniques.

J. P. MARTEL has been appointed manager of the design division, engineering department for E. I. du Pont de Nemours and Co. He succeeds MELVIN F. WOOD, recently appointed assistant chief engineer of the company. F. W. PARDEE, JR., will assist Mr. Martel with R. P. GENEREAUX as his assistant on special assignment.

* *

JAMES R. REED has been named manager of the commercial research department of the Allis-Chalmers Mfg. Co. JEROME F. FITZSIMMONS has been named supervisor in charge of research, and ANSON J. BENNETT, JR., becomes supervisor in charge of sales and analysis.

* *

D. S. WOLCOTT, vice-president of the Lukens Steel Co., has been appointed chairman of the Committee for Economic Development in the Coatesville Pa. community.

* *

GEORGE P. EICHELSBACH, JR., has been promoted director of manufacturing and engineering of American Stove Co. Mr. Eichelsbach has full responsibility for both manufacturing and engineering in all five plants of the company.

F. C. NEAL, JR., has been appointed manager of General Electric's new welding branch in Houston, Texas. Mr. Neal began organizing this branch in January of this year. He is a member of the American Welding Society. C. L. HELMS, who helped in the forming of the Houston branch, has been named office manager.

* *

JAMES D. GREENSWARD has been named assistant to the vice-president of the general machinery division of the Allis-Chalmers Mfg. Co. Mr. Greensward will assume important duties in the company's expansion program.

* *

IRVING S. OLDS, chairman of the broad of United States Steel Corp. recently received from the Air Services Placement Center in Chicago, a citation for the "excellent record of U. S. Steel subsidiaries in placing air veterans in positions for which they are best suited."

* *

BEN L. WISE, formerly assistant general manager of Federal Machine and Welder Co., has joined the National Electric Welding Machines Co. as production engineer.

* *

GEORGE KEMPER has been transferred to the Atlanta, Ga. district office of the A. O. Smith Corp. Mr. Kemper will assist in the sale of the company's distribution goods including welding electrodes and equipment.

* *

ROBERT M. ARNOLD has been elected a member of the board of directors of Allegheny Ludlum Steel Corp. Mr. Arnold is president of Arnold Engineering Co., Chicago, subsidiary of Allegheny Steel Corp.

* *

Recent changes in the general sales division of R. G. LeTourneau, Inc., Peoria, Ill., are the promotion of WENDELL RICHARDS to market research manager, CLOYD RICHARDS to general service manager; O. A. WILLIAMS to eastern sales manager succeeding HARRY CONN, resigned; and C. F. ZIMMERMAN to succeed Mr. Williams as district sales representative in Ohio, Indiana and Michigan.

* *

WALTER B. BRIGGS, formerly manager of the power transmission division of Ideal Industries, Inc., has been appointed general manager of the power transmission division of Lovejoy Flexible Coupling Co., Chicago.

* *

KENNETH AUSTIN, financial writer for the *New York Times*, has joined the public relations staff of United States Steel Corp.

EUTECTIC "*Low Temp*" EUTECTRODES*
for faster, better, more economical
METAL ARC WELDING

"*LowTemp*" EUTECTRODE 24 for CAST IRON
saved!
FROM SCRAP—HEAVY IRON CASTING
without
PRE-HEATING, DIFFICULT MACHINING, PLANT SHUT-DOWN

This 400 lb. cast iron casting was put back into service in 3 hours by arc welding with "*LowTemp*" EUTECTRODE 24. A structurally strong, color matching, machinable weld was obtained *without preheating!* This was possible because of the amazing surface alloying action of this special flux-coated electrode. Use this revolutionary "*LowTemp*" EUTECTRODE 24 to salvage your large and small, broken or worn cast iron parts.

EUTECTIC
"*LowTemp*" EUTECTRODES
are new types of metal arc welding electrodes which — 1. *Weld at lower base metal temperatures.* 2. *Deposit welds at exceptional high rates of speed.* 3. *Form welds equal to or better than base metal.*

OTHER OUTSTANDING "*LowTemp*" EUTECTRODES

STAINLESS "*LowTemp*" EUTECTRODES for stainless steels
"*LowTemp*" EUTECTRODE 28 for Brasses, Bronzes, etc.
"*LowTemp*" EUTECTRODE 2100 for ALUMINUM
"*LowTemp*" EUTECHROMS for HARD OVERLAYS
"*LowTemp*" EUTECTRODE 30 for COPPER

SOLVE YOUR METAL ARC WELDING PROBLEMS WITH EUTECTIC "*LowTemp*" EUTECTRODES*
Mail coupon or write on company letterhead for full information.

Castolin Eutectic
EUTECTIC WELDING ALLOYS CORPORATION
ORIGINATOR OF *Low Temperature* WELDING ALLOYS*
40 WORTH STREET NEW YORK 13, N. Y.

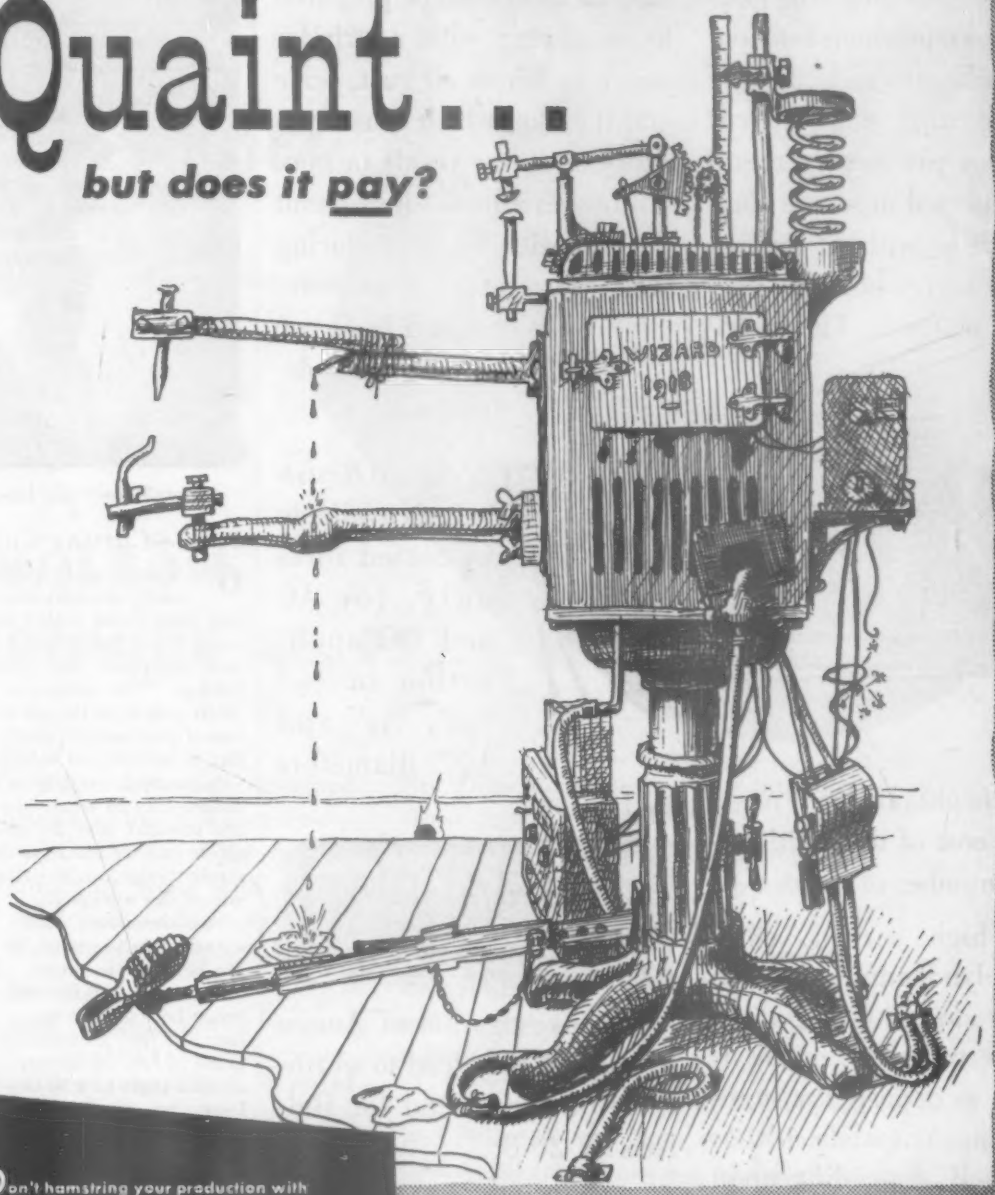
VISIT OUR BOOTHS G-103 and A-180 at National Metal Congress, Atlantic City, Nov. 18-22.

*Trade-Mark Reg. U. S. Pat. Off.

Please send me information on EUTECTIC "*LowTemp*" EUTECTRODES Dept. WE-11A
NAME.....
COMPANY.....
ADDRESS.....

Quaint...

but does it pay?



Don't hamstring your production with out-of-date resistance welding equipment. Time and money spent on keeping ancient machines in operation, training operators, etc., is *lost!* You'll step up production . . . reduce man hours . . . stay ahead of competition with modern, completely automatic electronically controlled SCIAKY welders.

Sciaky has a complete line of standard spot, projection, portable, seam and flash welders that are *engineered for production.* We're specialists also in the design of "tailor-made" multiple gang welders. Write today for details.

If you're going to the Metal Show . . .

The latest Sciaky welders will be in operation at the National Metal Congress in Atlantic City, November 18 to 22. You are cordially invited to visit our booth E-220 in the Exhibit Hall.

SCIAKY BROS. Inc.

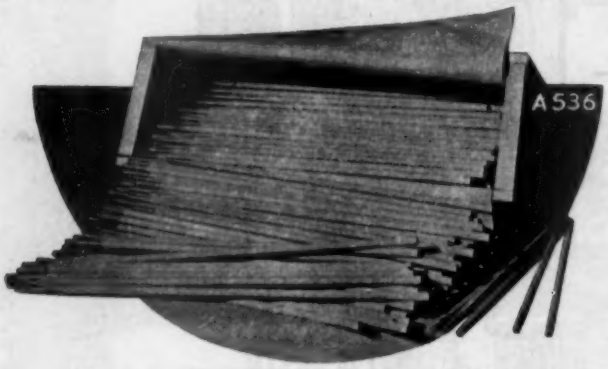
Offices and Representatives in Principal Cities

Plants in London and Paris

4915 W. 67th St., Chicago 38, Ill.

Resistwear — A New Hard-Surfacing Electrode of Low Cost and High Wear Resistance . . . . . .

Amsco *Resistwear* — the newest of Amsco products for Conservation Welding—offers an effective and economical method of protecting metal parts subjected to severe abrasion, with or without impact, with an overlay of more wear resistant material. The added service life obtained will repay the total cost of this hard-surfacing a number of times.



This high carbon, chromium-molybdenum, shielded arc electrode can be deposited on any ferrous base metal. It produces as deposited a hardness of approximately 400 to 500 Brinell, depending upon the degree of dilution of the base metal.

Resistwear does not require cold working in order to obtain its high degree of hardness. This characteristic makes it ideal for surface-hardening parts which are subjected to little work-hardening impact.

In applying *Resistwear* straight polarity is recommended for best results. The base metal should be prepared by removing with a grinder and wire brush all rust, scale and the like, which causes porosity and may result in non-uniform hardness throughout the deposit. When surfacing manganese steel, maximum hardness is obtained from two or more pass deposits.

Amsco *Resistwear* is available in coated form only, for AC and DC application in 1/8", 5/32", 3/16" and 1/4" diameters by 14" long.

An investigation of Amsco *Resistwear* may lead to worthwhile savings. Send for Bulletin W-20-B.

(Amsco Welding Products are produced and sold in Canada by Canadian Ramapo Iron Works, Inc., Niagara Falls, Ontario.)

AMSCO
Foundries at
Chicago Heights, Ill.; New Castle, Del.;
Denver, Colo.; Oakland, Calif.;
Los Angeles, Calif.; St. Louis, Mo.
Offices In Principal Cities
AMERICAN MANGANESE STEEL DIVISION
CHICAGO HEIGHTS • ILLINOIS
AMERICAN Brake Shoe COMPANY

NEW PRODUCTS TO USE

(*Continued from page 102*)

"Cut-O-Guide" for cutting steel plates

Flame-Cutting Guide

6 THE "Cut-O-Guide" is a new magnetic straight-edge guide for cutting steel plates with a hand torch. It is made from heat-treated aluminum alloy and equipped with aluminum magnet holders. The magnets, which exert a 30-lb pull, hold the plate in place regardless of whether it is rusty, oily or painted, flat or curved and hold it in any position —horizontal, vertical or overhead. The holders can be secured at any point along the straight edge by means of a thumb screw so that either or both ends of the straight edge can be extended beyond the end of the workpiece.

An aluminum collar (5/8 in. ID) is attached to the torch tip and rides along the edge of the angle. This serves as a steady rest, permitting a uniform distance between the tip and the work surface to be maintained. The cutting angle of the torch can be changed from a right angle to a 30-deg bevel by simply loosening a thumb screw. Standard straight edges are 3 ft long but a longer model is available and so are extra holders for holding templates for contour cutting. UNIVERSAL POWER CORP., Cleveland 15.

* *

Automatic Welding Studs

7 REDUCTION in assembly time and labor costs when welding low-pressure heating boilers and jacketed vessels is now afforded by the use of "Staybolt" studs. This stud has a projecting end provided with a groove which permits it to be broken off flush with the plate surface after it has been automatically welded. A flat washer is then dropped over the stud end to act as a back-up for the plug-welding operation which completes the staybolt installation. By using a portable welding gun and automatic timer controls, these studs can be welded at a rate of 100 to 200 per hour. NELSON SALES CORP., Lorain, O.

Your best bet

for cast iron welding jobs

. . . WILSON ELECTRODE No. 97

Here's a rod that's especially designed for all-position welding of cast iron—where machineability of the deposit is not important. Made with a core wire of mild steel with an extruded coating, the Wilson No. 97 offers these notable features:

- A pink coating that acts as a flux . . . controls the arcing characteristics, permitting the use of low currents so desirable in cast iron welding.
- Smooth, uniform deposits of higher tensile strength than the cast iron.
- Light slag that is easily removed.

No. 97 is available in three popular sizes: 3/32", 1/8" and 5/32" diameters, 12", 14" and 14" lengths respectively. It is recommended for welding of cylinder blocks and heads, bearing blocks, machine parts, large frames and similar pieces. For best results, use reverse polarity with D. C. Alternating Current may also be used.

For full information about No. 97, and Wilson's complete line of electrodes, fill in the coupon and mail it today for a copy of Catalog ADW-75. Or, if you prefer, write your nearest Wilson distributor

WE

WILSON WELDER & METALS CO., INC.

60 East 42nd Street
New York 17, N. Y.
(IV)

Please send me a copy of Wilson Electrode Catalog ADW-75.

Name_____

Firm_____

Address_____

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WILSON WELDER and METALS CO., INC.

General Offices: 60 East 42nd Street, New York 17, N. Y.

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Represented Internationally by Airco Export Corporation

Fuse-Well
Cast
Welding Rods

THE STANDARD OF QUALITY
Throughout the World

CAST ALUMINUM
WELDING RODS
OF STANDARD ANALYSIS

PLAIN AND ALLOYED GRAY IRON
WELDING RODS
AND ELECTRODES

THE CHICAGO HARDWARE FOUNDRY CO.
Dependable Since 1897
1146 ENGINEERING BUILDING
NORTH CHICAGO, ILLINOIS

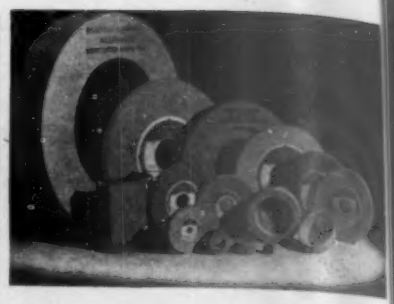
Your answer to greater output of better seam-welded tubing at lower cost . . .

VICTORY *Automatic*
Seam Welder

With an extremely high speed production per minute of uniform, tight, straight welds, this Model 0412 VICTORY *Automatic* Seam Welder makes high volume *a fact* on seam-welded rounds, squares, and other shaped tubes. This machine takes 4" to 12" dia. pre-formed tubing, 18 ga. to 3/16" wall thickness, and is adaptable to gas, heliarc, and atomic hydrogen methods of welding, or can be used with Union Melt or Lincolnweld welding heads. A chain-type drive prevents work slippage while passing under the welding head, and you save expense of weld grinding and finishing because of its ability to operate without splatter of metal.

VICTORY *Automatic* Seam Welder assures precision welding with speed at amazing low cost. Let our engineers give you complete details.

VICTORY ENGINEERING & MACHINE WORKS, Inc.
3000 Chouteau Ave., St. Louis 3, Mo.



"32 Alundum" abrasive gives grinding wheels a faster, cooler cutting action

Oxide Abrasive

8 A NEW aluminum oxide product "32 Alundum" is an abrasive in which each grain forms as a complete, single crystal. The individual crystals have many dihedral angles and plane surfaces, providing a multitude of sharp cutting edges. The result, states manufacturer, is to give the grinding wheel a faster and cooler cutting action with longer life and fewer dressings. NORTON Co., Worcester, Mass.

* *

Headrest Spectacle

9 THE new "L-T-B-50" (low-temperature brazing) spectacle is a lightweight plastic design with 50-mm lenses and a headrest feature eliminating the usual pressure on the nose and face. The spectacle may be flipped rapidly to the "up" position to permit inspection of the work and returned as quickly to the downward "on guard" position. Its all-around ventilation prevents fogging. JACKSON PRODUCTS, Detroit 7.

* *

Oxygen Indicator

10 M. S. A. Type C oxygen indicator measures the oxygen content of gaseous mixtures by means of an electrolytic detector cell made up of a plastic container. A hollow carbon tube and metallic plate serve as electrodes in approximately an ounce of liquid electrolyte. Polarization in the cell causes hydrogen to be deposited on the carbon pole. When a gas sample containing oxygen is passed through the hollow carbon electrode, diffusion through the porous carbon causes the oxygen to combine with the "electrolytic hydrogen." This reduces the internal resistance of the cell and causes its current and voltage output to be measurably increased. A direct meter indicates the percentage of oxygen within 2% accuracy. MINE SAFETY APPLIANCES Co., Pittsburgh.

COMING
IN DECEMBER-
WELDING
IN THE HOME
Watch for this article

Get Latest Style and Design

YES, it's *easy* to pick the right welding accessories when you select from the wide Allis-Chalmers line. Latest style and design are combined with large variety of size and type to make *proper* selection a simple, easy matter.

You'll find ruggedly built, lightweight helmets in both rivet and non-rivet type . . . cool operating, strongly constructed electrode holders in jaw type, screw type and new spring-lever type — heavily insulated, yet perfectly balanced for easy handling . . . complete welding accessory kits with all necessary equipment for operating welders . . . flexible, tough, water and oil resistant welding cable . . . glare-eliminating filter lens . . . wire brushes . . . gloves . . . and other arc welding needs.

For *all* welding requirements it will pay you to check the *entire* Allis-Chalmers line, including: Ampac a-c welder with *magic arc control*, Weld-O-Tron d-c electronic welder for *thin gauge* welding, and Allis-Chalmers *production-proved* electrodes. Contact our nearby welder dealer or sales office . . . or write direct to ALLIS-CHALMERS, MILWAUKEE 1, WIS. A 2115

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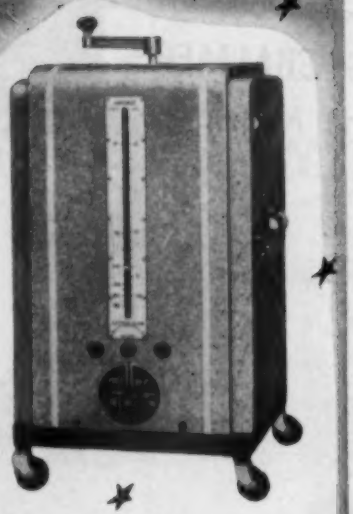
One of the Big 3 in Electric Power Equipment
Biggest of All in Range of Industrial Products

Welding Equipment

ONCE IN A BLUE MOON...



★ Once in a blue moon the boys in the shop get a piece of equipment to which they give instant approval. The Miller A.C. Welder is just that kind of machine!

The only way to know real welding pleasure is to grab hold of the electrode holder on a Miller and strike an arc. Try it! See how easily the arc is established. Feel the steady, even, sure arc. Watch the metal being deposited faster.

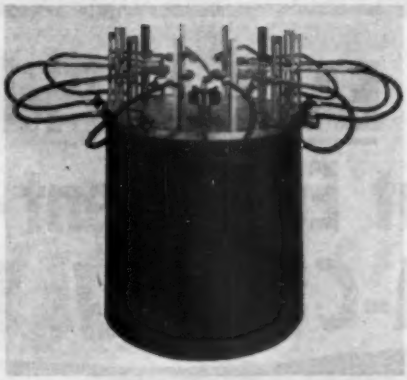
Once you have "run a bead" with a Miller A.C. Welder you know you have found that "once in a blue moon" piece of equipment.

Ten different models and sizes—all emphasizing Continuous Current-Arc Stability-Safety-Speed and Efficiency.

Stop at your jobber's store—try the Miller. Write for full information.

Miller AC Welders

MILLER ELECTRIC MANUFACTURING CO.
APPLETON, WISCONSIN



Heat treater for experimental silver soldering, preheating, flame hardening, etc.

Heat Treater

11 This midget heat treater is suitable for experimental and development work involving silver soldering preheating, flame-hardening and annealing, as well as for small-scale production jobs. The unit has a number of gas heating coils and a holding chuck rotated by a variable-speed drive. Adjustable burner arms make it possible to concentrate the heat on any desired section of the work. Various types of burners are available for different applications. Gas Appliance Service, Inc., Chicago 14.

* *

Pipe Edge Cleaner

12 An adjustable pipe skelp edge cleaning machine is offered by American Foundry Equipment Co. for removing scale from pipe edges prior to resistance welding. The cabinet and hopper are of knock-down welded construction fabricated from ½-in. steel plate with heavy steel reinforcing members. Steel plates 1-in. thick line the inner part of the cabinet, and a rubber curtain seals the exit and entrance openings for the stock. This machine is made adjustable over the complete range of tubing sizes and is designed to be installed in the tube mill production line. The abrasive-metallic shot or grit—is thrown by a unit called the "Wheelabrator" which consists of cast-alloy blades, control cage and impeller. The machine is said to clean preformed tube edges at a speed of from 70 to 90 ft per minute to provide a virgin metal surface for the electrode contact after the plate has been formed into the tube. American Foundry Equipment Co., Mishawaka, Indiana.

* *

Spray-Type Washer

13 For the quick and thorough washing of metal parts on racks, this new spray-type washing machine may be used individually or in a series where the washing operation requires several steps. The top of the unit is at working height, and all connections are readibly accessible. Spray nozzles are adjustable and replaceable, and the machine can be used with submerged agitation to remove caked greases and abrasives. Optimus Equipment Co., Matawan, N. J.

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Don't be a middle-man—become an independent oxygen manufacturer and *earn all of the profit!* Learn what we can do for you before you "buy" cylinders or "service rights" from an oxygen and acetylene manufacturer:

Without any capital investment by you, we are prepared to install a new, patented Air Products, Inc., oxygen generator for you. We will instruct your employees in its operation, maintain it in first-class condition and provide service at regular intervals for efficient, economical and safe operation. This modern complete oxygen producing unit will be leased to you under a long term contract which saves you a capital investment of approximately $25,000 or more. Under our plan *you actually own the oxygen cylinders* and all other facilities except the Air Products, Inc., oxygen producing equipment.

During the war Air Products, Inc. produced a great many new-type oxygen generators for the armed forces. Now they are available for peacetime production of pure, dry oxygen—at low cost and high efficiency. The generator features the exclusive Air Products, Inc. patented oxygen compressing system, which eliminates the need for an oxygen gas-holder, water lubricated oxygen compressor, and oxygen drying equipment.

Write us today giving your estimate of the average number of cubic feet of oxygen you can sell per month. Also the amount of capital you are prepared to invest in this profitable industry. Leases already signed will take up our production for several months. Therefore, we suggest that you arrange a lease now to insure earliest possible installation. This will allow time for you to obtain cylinders, prepare building, etc.

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If you are a consumer of oxygen in excess of several hundred thousand cubic feet per month we have a money saving service for you—a service which is now being utilized with complete satisfaction by several very large and internationally known corporations. Inquiries are invited.

"Fairlead Carrier" bronze overlaid with Ampco-Trode 250.

When parts are subject to severe wear, Hyster Co. uses

AMPCO-TRODE

REG. U. S. PAT. OFF.

COATED ALUMINUM BRONZE ELECTRODES to build protective, wear-resistant overlays

The various grades of Ampco-Trode give you these outstanding characteristics:

1. High tensile properties, with ultimate strengths ranging from 65,000 to 101,000 psi, and yield strengths from 35,000 to 69,000 psi.
2. High impact strength to resist shock loading.
3. Good bearing properties.
4. Excellent corrosion resistance.
5. Controlled hardness, from 115 to 300 points Brinell.
6. Higher ductility—tensile-strength ratios.
7. Higher fatigue resistance.
8. Welds are not hot short; cracking is eliminated.

W-94

Because their type of heavy earth-moving equipment operates under rough service conditions, often many miles from repair and service facilities, The Hyster Company of Portland, Oregon, and Peoria, Illinois, depend on Ampco-Trode electrodes and Ampco Metal to safeguard the vital parts of their products.

One standard application of Ampco-Trode electrode usage in Hyster equipment is the overlaid wear plate at the bottom of the "Fairlead Carrier." The fairlead on the mast had in the past been made with castors having a very short life due to extreme wearing conditions of this point.

This wear plate was overlaid ¼" on both sides with ¼" Ampco-Trode 250 bronze deposit. Mr. W. C. Smith of Industrial Specialties Co., reports, "Ampco-Trode has come to the rescue. It is doing a fine job with long life at little cost."

Join the ever increasing number of manufacturers who are turning to wear-resistant Ampco-Trode overlays and Ampco Metal for reliable, trouble-free service.

AMPCO

Ampco-Trode is a product of

AMPCO METAL, INC.

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('TIS ONE THING YE'LL NEVER RECOVER AFTER YE LOSE IT)

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YORK'S 77
CAST IRON BRAZING
FLUX

1. Fear of overheating can be forgotten.
2. Cleaning and grinding are unnecessary, because "York's 77" penetrates through grease, oxides, etc.
3. Chipping is unnecessary, because a satisfactory bond can be obtained on oxidized surfaces.
4. Deteriorated cast iron can always be welded successfully with "York's 77."

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PROFITABLE WELDING
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Model 60 turning rolls of steel construction for manual and automatic welding

Turning Rolls

14 MODEL 60 turning rolls consist of an independently mounted idler and power unit to aid in the automatic and manual welding of tanks and other cylindrical shapes. Both units are adjustable for any diameter of weldment and a variable-speed drive permits the operator to select a speed of rotation from 0 to 70 in. per minute. Both power and idler units have a capacity of 3,000 lb and are equipped with rubber-tired wheels as standard equipment. The all-steel construction of these rolls combines extreme rigidity with comparatively light weight. REED ENGINEERING CO., Webb City, Mo.

* *

"Circle Burner" for flame-cutting torches

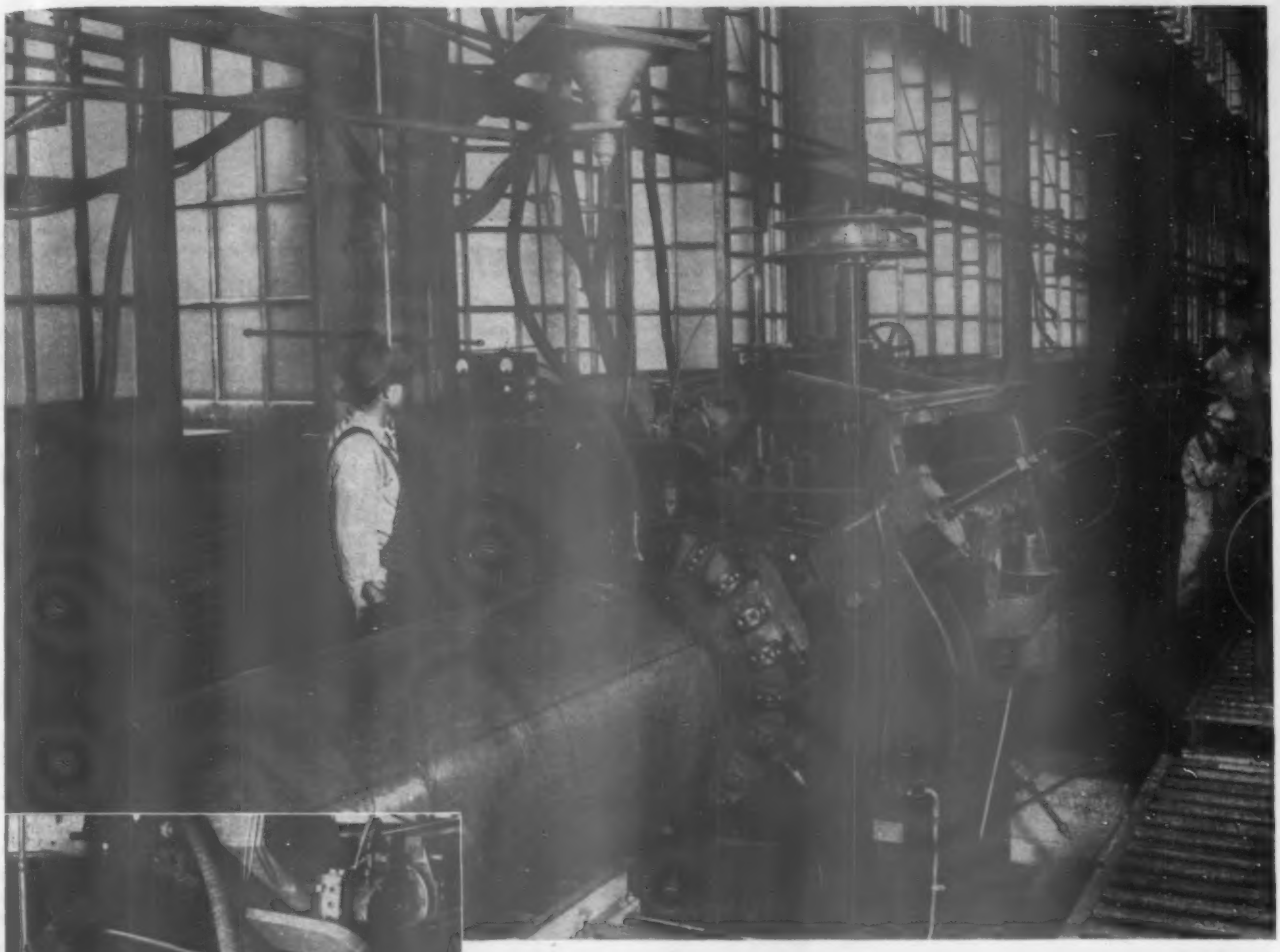
Contour Cutter

15 A NEW "Flash Circle Burner" has been developed to cut accurate circles, curves or straight lines in steel plate. It consists of a ball-bearing rotary head (shielded from slag or heat) which allows free running operation of the cutting torch clockwise or counter-clockwise, vertical or horizontal. The torch is always parallel to the centering pin to insure an even cut. A square radius bar prevents twisting or clocking, and a heat-treated tracking wheel prevents gumming or sticking when exposed to the flame. Circle burning to the edge is provided by an adaptor set at a distance behind the head. SCIENTIFIC RESEARCH CO., Portland, Oregon.

* *

Sheet-Metal Electrode

16 "SM" is the name of a new "Spray-type" E-6013 electrode said to produce a cleaner, stronger, more uniform weld of lower penetration when joining sheet metal. Its lower heat requirements eliminate "burn-throughs" and "suck-ins," states manufacturer, and there is less slag removal and finish grinding needed. Application may be likened to "brushing on" weld metal. P&H HARNISCHFEGER CORP., Milwaukee.



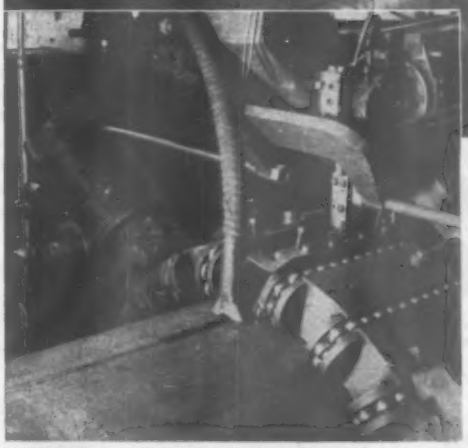


Illustration shows the "Cage." This patented feature is the "heart" of the welder. Write for details.

Illustration shows preformed tubes entering the back of the "Berkeley" where they are aligned before being welded.

Berkeley Continuous

Longitudinal Seam Welders for *HIGH* Production at *LOW* Cost

Every day the "Berkeley" turns out miles of seam welds on big production jobs . . . it's a cost saver, too, for the small job shops.

The "Berkeley" uses the melt submerged electric-arc and all welds are uniform and of X-ray quality.

There's a size "Berkeley" to weld preformed tubes 5" to 36" in diameter.

Write us, we will suggest the best type for your requirements.

PENN TOOL & MACHINE CO.

DANVILLE, ILLINOIS

NOW YOU CAN GET THESE LONG-SCARCE RODS FOR LOW-TEMPERATURE WELDING. . . AT PRICES YOU'LL LIKE!

All-State

We've made an important scoop—have just received thousands of pounds of No. 11 HI-TENSILE NICKEL SILVER BRAZING ALLOY ROD and No. 13 HARD OVERLAY NICKEL SILVER ROD. Order as much of either of these low-temperature rods as you want—at prices the best you'll find on the current market. Indicates whether you'll accept the other size in case we run short of the size you order.

		PRICE PER POUND						
	Size	1–9	10–24	25–49	50–99	100–499	500–999	1000 up
No. 11 rod (1)	1/16	1.90	1.81	1.72	1.63	1.55	1.47	1.40
	1/8	1.77	1.68	1.60	1.52	1.44	1.37	1.30
No. 13 rod (2)	3/16	1.43	1.36	1.29	1.23	1.17	1.11	1.05
	1/4	1.38	1.31	1.24	1.18	1.12	1.06	1.00
		1–4	5–9	10–24	25–99	100 up		
No. 11 flux (Order 1 lb. flux for each 10 lb. rod)		1.00	.90	.85	.81	.77		

(1) This versatile rod brings all the advantages of low-temperature welding to work on steel, stainless steel, copper nickel, and nickel; recommended for production and fabrication of light steel and nickel alloy sections.

(2) This rod is not excelled by any low-temperature rod for general repair of worn or broken parts; recommended wherever resistance to frictional wear is desired.

We will ship orders up to 100 lb. *immediately*, f.o.b. White Plains, N.Y., billing you through our distributor for your area. Orders will be filled in the order received. The All-State line includes a wide range of low-temperature welding and brazing alloys and fluxes.

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SIMPLIFIES YOUR RESISTANCE WELDING PROBLEMS

Write today on your official letterhead for descriptive Bulletin SP-75B

Illustrated - 7.5 KVA Bench-type water-cooled Spot Welder.

Stock delivery!

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Jeep-welder combination brings the weldor to the work for on the job repair

Jeep Welder Combination

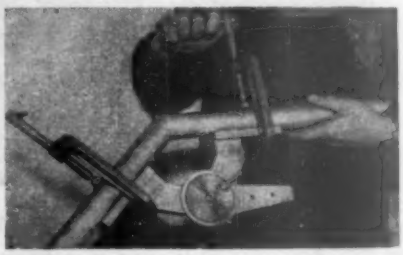
17 MOUNTED in the conventional army Jeep is a 200-amp arc welder having a welding range of 15 to 250 amp driven from a power take-off. The welder is equipped with two 100-ft cables (ground and lead), a fully insulated electrode holder and a weldor's helmet complete with protective lens. The framework, top and sides of the Jeep act as protection for the welder. WELDING ENGINEERING Co., Milwaukee 2.

★ ★

Work Holders

18 DESIGNED to hold together two parts, whether round or square bars, flats or angles, are the new portable "Duo-Square" work holders, which are, in effect double vises. The holders are cast-aluminum brackets supporting two clamping faces that may be positioned at any angle, depending upon the work.

The models available consist of the "Adjustable," in which the two clamping faces are movable through 0 to 180 deg, the fixed "Ninety" for accurate 90-deg joints, the fixed "Straight" for line butt joints and the "3-Way" for making "T" joints or corner-and-leg joints. MCFERRON-MYERS PRODUCTS Co., Cleveland 14.



"Duo-Square" work holders give a vise-like grip for angular welding up to 180 deg

★ ★

Copper-Tungsten Electrodes

19 A LINE of copper-tungsten alloys for resistance-welding electrodes is offered by Ampco Metal for conditions where electrodes are to be held over a fairly long period at high heat and pressures or where water cooling is not adequate. Main applications of these alloys are for inserts on projection-welding and flash-welding dies, upsetting and forging dies, etc. The new alloys meets RWMA specifications and is available in rod, bar and insert form. Standard resistance-welding electrodes may be secured with special copper-tungsten facing or special-spot welding tips. Two silver-tungsten alloys are also being produced in the form of rods, bars and inserts for such uses as circuit breaker contacts and special welding applications. AMPCO METAL, INC., Milwaukee 4.

RECIPE *for* *Excellent* WEAR-RESISTANCE *and* HIGH IMPACT *When You Need* SELF-HARDENING ALLOYS

Many users of wear-resisting alloys have found ISOROD the most efficient alloy where high impact is combined with abrasion such as is encountered on power shovel teeth and dragline buckets.

ISOROD gives nearly three times the wear of competitive alloys in the self-hardening class, resists higher impact and will not chip or spall off under severe use, even on manganese steel.

It is a favorite with a host of quarries because of:

EASE OF APPLICATION—either AC or DC and in all positions.

LOW SPATTER LOSS—less than six percent. No fireworks.

VERY STABLE ARC—quiet and efficient.

NO FLUX TO BOTHER WITH—no waiting for slag to lift.

HIGH SPEED APPLICATION—9 lbs. per hour using ¼" electrode.

NO POROSITY—deposits are free of all pin holes, checks and cracks.

Coatings are highly moisture-resistant and non-poisonous.

Absolutely will not chip nor spall off of any steel.

EXCEEDINGLY TOUGH—185000 P.S.I.

BRINELL HARDNESS—520–580—Rockwell C 52–56.

Insist that your jobber supply you with ISOROD SELF-HARDENING. Available in all standard sizes from 3/32" to ¼" diameters. For light or heavy work.

When you use ISOROD as the hot rod with Mangatone NM to repair or rebuild worn manganese steel castings you will obtain the toughest, most wear-resistant surface that you have ever thought of. Try this combination when you have to repair your crusher plates, gyratory mantle, dragline bucket or shovel teeth and you will be more than satisfied with results.

Buy from your independent jobber today. Repair that tough job. Learn how fast and easy ISOROD is applied, and experience real savings in self-hardening applications.

RESISTO-LOY CO., GRAND RAPIDS 7, MICH.

Write our nearest representative for details.

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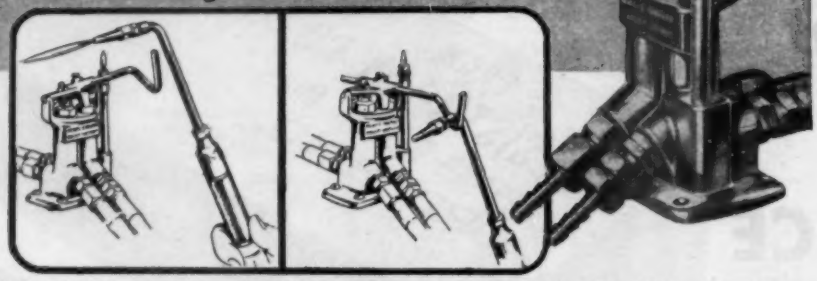
WELDIT GASAVER

● Cuts Gas and Oxygen Cost!
● Eliminates Dangerous Fire Hazard!



With Weldit Gasaver installed the operator simply hangs his torch on the handy lever rod of the Gasaver. The weight of the torch pulls the lever rod down, closing the valves of the Gasaver, thus shutting off both gas and oxygen intake lines. The usual idle flame and needless waste of oxygen and gas between operations is thus eliminated—no fire hazard or danger of injury to workers.

When the torch is again picked up for further welding operations, the operator passes it across the pilot light of the Gasaver, thereby instantly igniting the torch at the pre-adjusted flame, ready for work — no adjustments to make.

Gasaver can be installed any convenient place on the line between regulators and torch. Most of America's largest production plants are now Gasaver equipped.

Listed as standard by Underwriters' Laboratories and by New York City Board of Standards and Appeals.

Weldit INC. SINCE 1918

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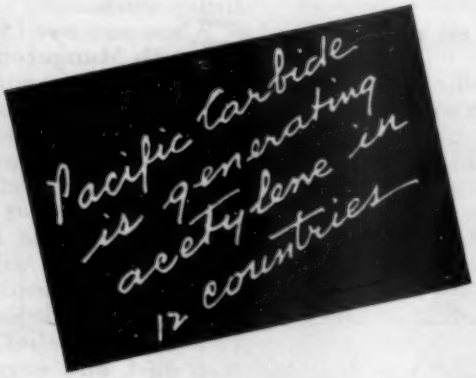
PACIFIC CARBIDE



Yield and uniformity of Pacific Carbide have been proved . . . in many types of generators, in this and eleven other countries. It is a tested product that meets International and Federal specifications. All standard sizes; packed in 100-lb. and 500-lb. drums. Location of our plant on deep water at Portland, Oregon, permits low-cost delivery to all deep water ports. For details, address:

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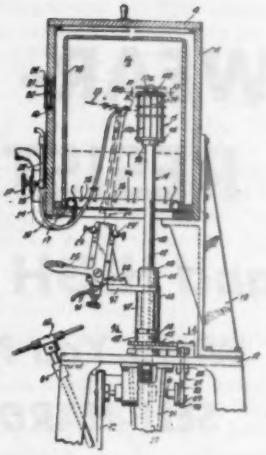
351 California Street, San Francisco 4

Important: These companies are not connected in any way with any other producer of Carbide.

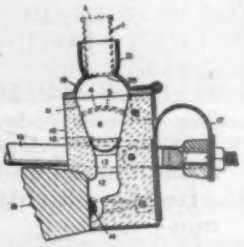
From the Patent Office



Hydrogen-Arc Welding

2,405,828. WILLIAM C. HUGULEY, Belleville, N. J. Filed July 28, 1944. Issued Aug. 13, 1946.

An apparatus for arc welding comprising a chamber, into which is introduced the work to be welded. A pair of electrodes are pivotally mounted and adjustably positioned in the chamber. There are also a means for advancing the work relative to the electrodes, means for enveloping the electrode ends and work in hydrogen and means to seal the hydrogen from the surrounding room atmosphere.

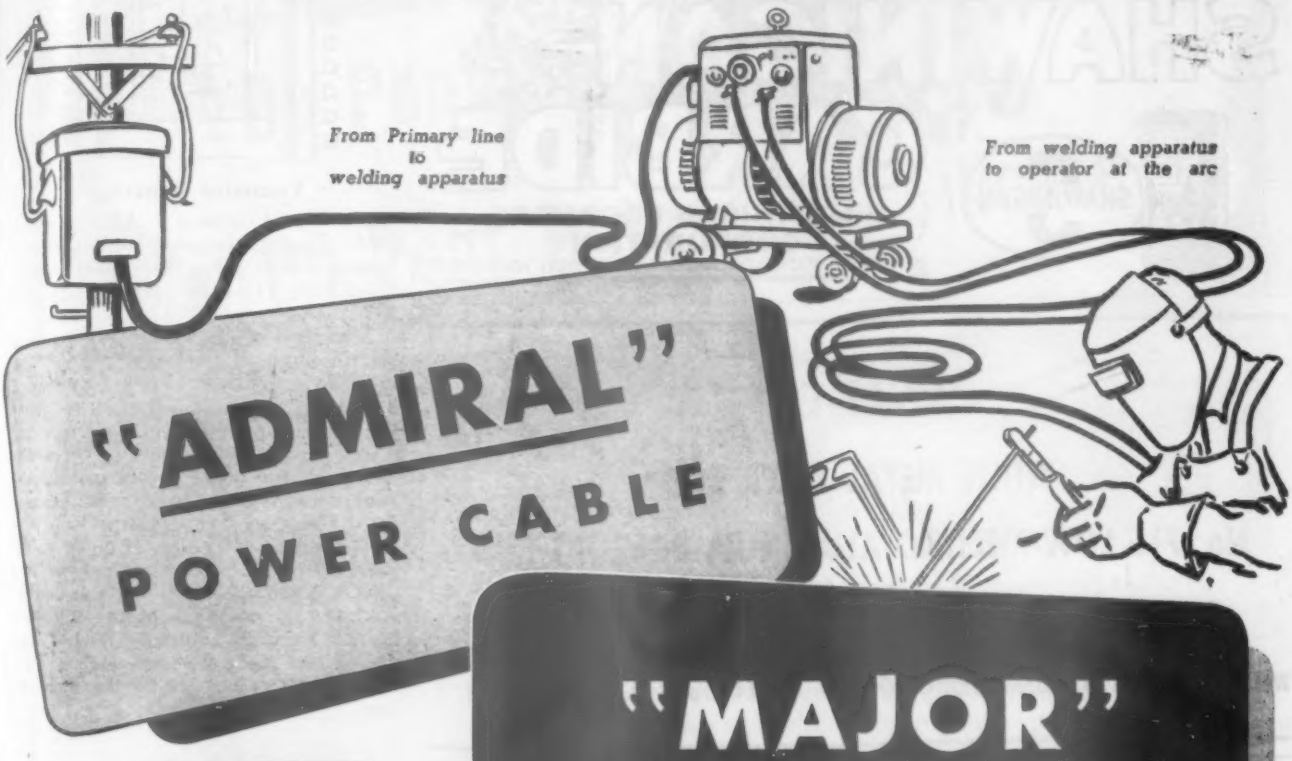


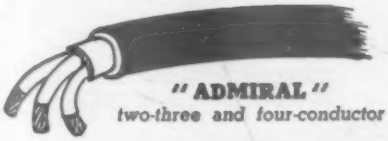
Thermit-Welding Material

2,408,291. CHARLES A. CADWELL, Cleveland, assigned to THE ELECTRIC RAILWAY IMPROVEMENT CO., Cleveland. Filed Feb. 3, 1944. Issued Sept. 24, 1946.

In a method of producing highly heated molten metal for use in welding, the steps which comprise inducing an exothermic (heat producing) reaction between copper oxide and aluminum. The amount of aluminum is insufficient to reduce all of the oxide, and so an agent is included in an amount slightly in excess of that required to complete the reaction. The latter agent is taken from the group consisting of manganese, manganese boride, silicon, silicon carbide and zirconium.

FOR POWER TRANSMISSION





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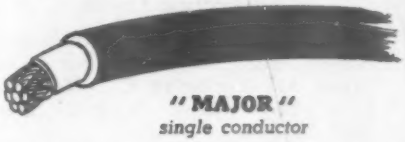
two-three and four-conductor



"MAJOR"
single conductor

"ADMIRAL"

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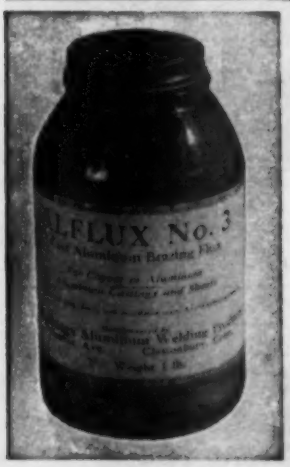

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This flux may also be used with good results on other metals. ALFLUX No. 3 is manufactured of the highest quality pure chemicals which have been thoroughly and carefully compounded. It is an exceptionally fine flux which adheres to the surface to be brazed and produces a faster and more economical weld.

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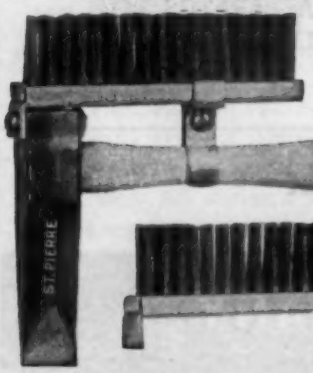

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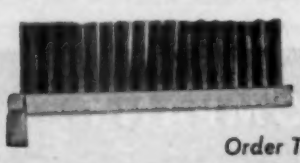

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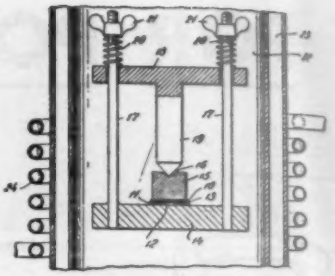
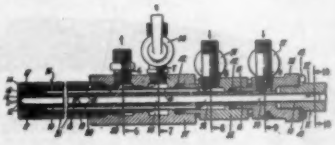


Vacuum Brazing

2,406,310. GEORGE J. AGULE, Stamford, Conn., assigned to MACHLETT LABORATORIES INC., Springdale, Conn. Filed Feb. 11, 1944. Issued Aug. 27, 1946.

A method of closing an opening in a metallic base by brazing a beryllium member to the base. First, a washer of a brazing medium is placed on the base to encircle the opening, and the member is placed upon the washer to close one end of the opening. The base with the washer and member in place is then set upon a support, and pressure is applied to the member, tending to move it toward the base. The space about the base and the assembled parts is evacuated, and the assembled parts are heated in the vacuum until the washer has melted and the molten brazing medium has issued from between the member and base.

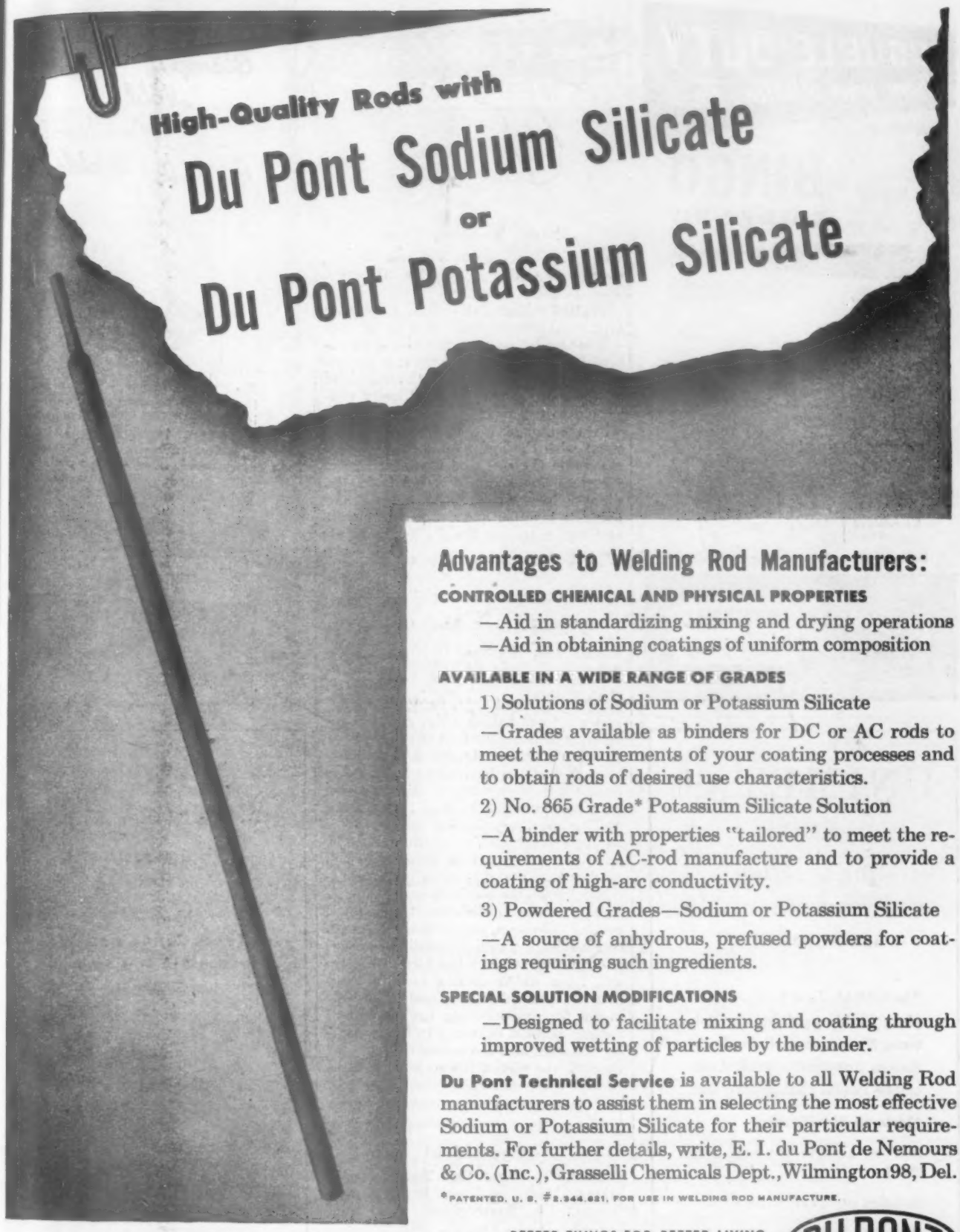
* *



Piercing Torch

2,407,972. ROBERT B. AITCHISON, Staten Island, N. Y., assigned to THE LINDE AIR PRODUCTS CO., New York City. Filed August 28, 1942. Issued Sept. 24, 1946.

An oxy-acetylene torch designed to pierce a deep hole in a metal body. The long nozzle has a central tube open at one end, and oxygen is supplied at the other end of this tube. A second tube surrounds the central tube and fuel gas is supplied to the space between these two tubes. An intermediate tube surrounds the second tube, creating a space to which oxygen is supplied. A baffle tube surrounds the intermediate tube, and a liquid cooling medium is supplied to the space between the intermediate baffle tubes. A ring-shaped nozzle block is attached to one end of every tube except the baffle tube; an outer tube is secured to this block. The cooling medium flows from the nozzle block in the space between the intermediate and baffle tubes, then around the end of the baffle tube, and returns through the space between the baffle tube and the outer tube. Passages formed in the nozzle block meet at common outlets spaced about the central tube; one group of passages connects with the fuel gas supply space and another group connects with the oxygen supply space.



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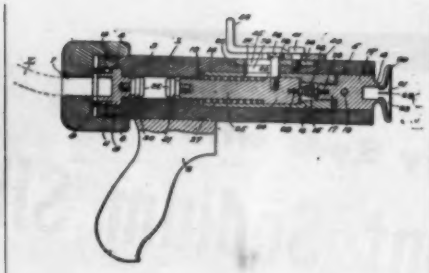

Stud-Welding Gun

2,401,655. GEORGE VINSON MOORE, Compton, Calif. Filed Mar. 31, 1944. Issued June 4, 1946.

A stud-welding gun including a case, a cushioned contact supported in one end of the case for engagement with the positive lead of a welding circuit, a pin-engaging chuck supported in the other end of the case, a plunger electrically connected to the chuck, a contact movable with the plunger into and out of engagement with the first-named contact, and means on the case and rotatable in one direction for successively shifting the plunger in one direction to bring the contacts together and complete a circuit and then releasing the plunger to break the circuit.

* *

Flame-Hardening Torch

2,407,370. HOWARD G. HUGHEY, Fanwood, N. J., assigned to AIR REDUCTION CO., INC., New York City. Filed Mar. 13, 1944. Issued Sept. 10, 1946.

A gas torch having a tip, gas passages opening through the face of the tip from which a combustible gas mixture may issue to burn as heating flames, cooling passages through which cooling medium may be circulated to cool the tip, the cooling passages having an entrance through which cooling medium may be admitted and an exit through which cooling medium may pass and be discharged from the torch through a return-flow pipe after circulating through the cooling passages, quenching passages communicating with the cooling passages and opening through the face of the tip and from which cooling medium may issue as quenching jets, and adjustable means for proportioning the amount of cooling medium delivered to the quenching passages and the amount discharged through the exit of the cooling passages

* *

Eye Shield

2,406,608. WILLIAM J. JOYCE, Southbridge, Mass., assigned to AMERICAN OPTICAL CO., Southbridge. Filed Aug. 6, 1943. Issued Aug. 27, 1946.

An interchangeable face-engaging member for the eye cups of goggles. This member is of annular shape and comprises a number of threadlike fibrous portions joined by a binder lying substantially in a single plane. A layer of non-metallic stiffening material forms a rigid backing member for supporting the opposed ends of the fibrous portions in a single plane.

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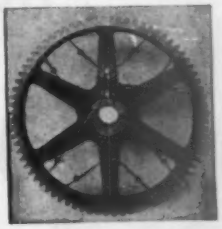

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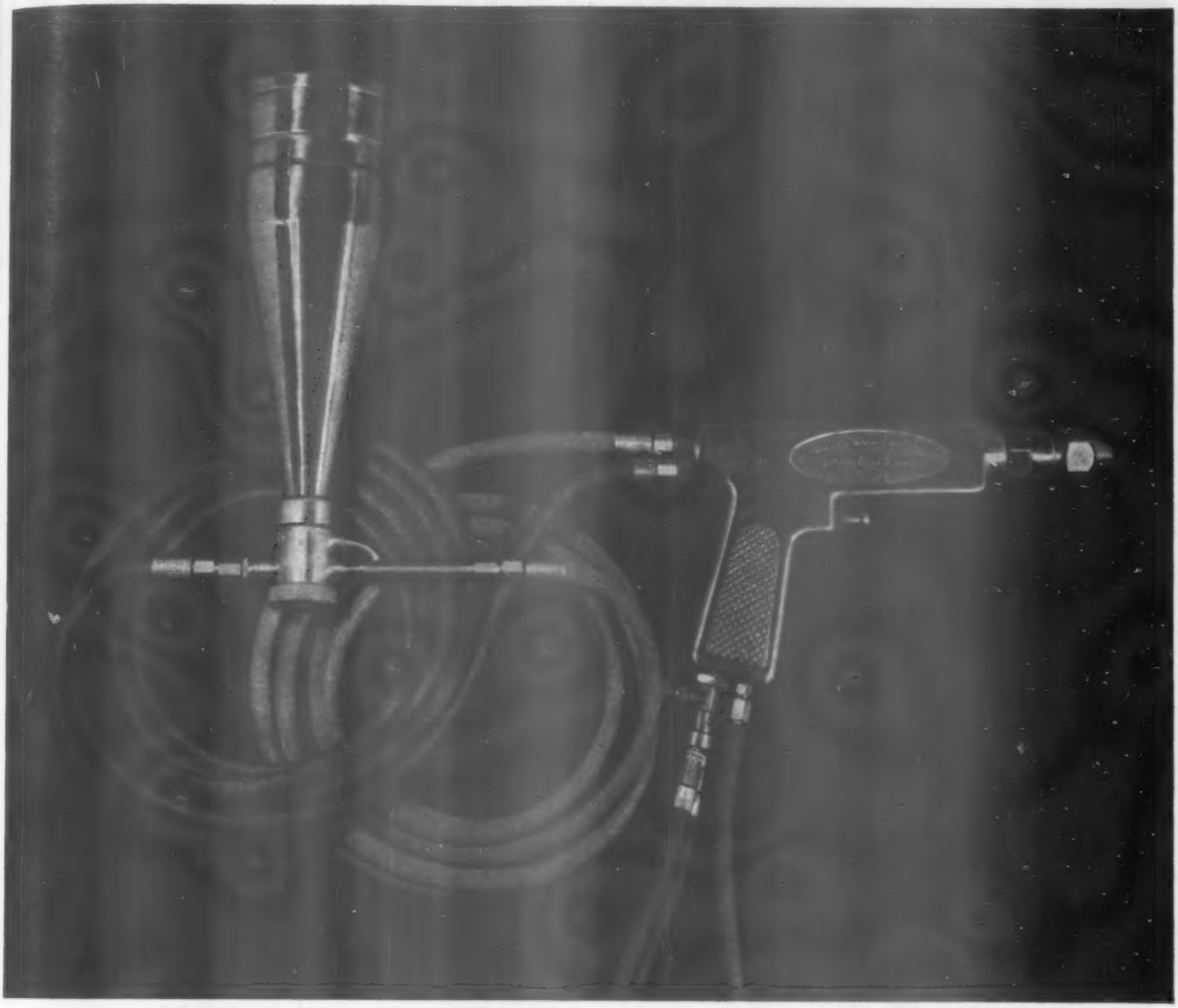

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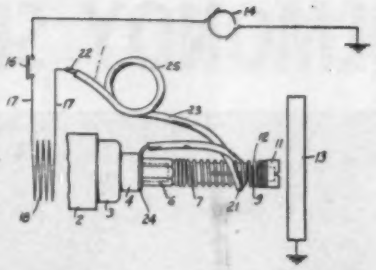
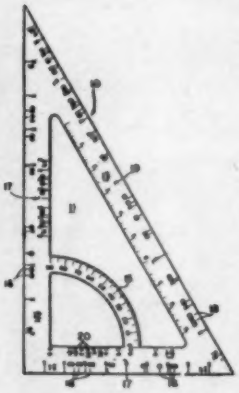


Stud-Welding Arc Stabilizer

2,406,474. WILLIAM W. PERRIN. Albany, Calif., assigned to TED NELSON, San Leandro, Calif. Filed Jan. 19, 1944. Issued Aug. 27, 1946.

In stud-welding machine, an electrode-carrying chuck, a conductor in series with the chuck and coiled therearound adjacent the electrode, and means for supplying current to the conductor.

* *



Layout Instrument

2,407,368. GERALD J. HENJUM, Hollywood, Calif., assigned one-third to ALBERT H. FARNESS, North Hollywood and one-third to CHESTER H. SHERER, Los Angeles. Filed May 22, 1945. Issued Sept. 10, 1946.

A layout triangle for piping having a number of scales disposed along its edges. These comprise base line projections of equally divided circular arcs corresponding to the inside and outside diameters of standard pipe sizes, together with scales of the developed circumference of similar pipe sizes divided into units corresponding to the spacings of the circular arcs.

* *

Seam-Welding Electrode

2,407,676. ALEXANDER L. MUNSON, Detroit. Filed Jan 3, 1944. Issued Sept. 17, 1946.

A seam-welder wheel having a work-engaging rim secured to the periphery and an annular coolant passage located adjacent the surface of the rim. The means for circulating coolant through the passage includes a number of radially extending, circumferentially distributed inflow passages and a corresponding number of radially extending circumferentially distributed outflow passages. The inflow and outflow passages open into the annular passage in circumferentially alternate relation to each other.

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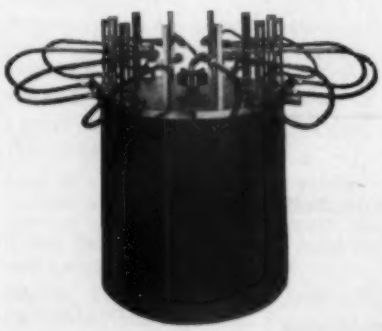

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Underwater Electrode

2,408,175. PAUL PEILLON, Cairo, Egypt, assigned to SALVAGE & MARINE Co., S.A.E., Cairo, Egypt. Filed March 29, 1943. Issued Sept. 24, 1946.

An underwater arc-welding electrode especially adapted for use in sea water. It comprises a steel rod having a non-conducting flux coating a separate covering layer impregnated into the outer portion of the flux coating. The covering layer consists of an organic waterproof insulating material that is capable of being vapo·ized by the welding heat, without undue decomposition or the production of carbonaceous matter, to form a body of vapor that protects the welding zone from the action of the water. The organic material is selected from the group consisting of waxes and drying oils.

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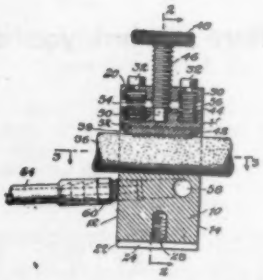

Carbon-Arc Electrode Holder

2,405,403. STEVE CHRONIS, CORONA, N. Y., assigned to SOLAR AIRCRAFT CO., San Diego. Filed Oct. 19, 1944. Issued Aug. 6, 1946.

A carbon-arc electrode holder having an open channel and a contact shoe mounted for limited vertical movement. A contact face at the bottom of the shoe is positioned at the open top of the channel and complements the face of the channel to form a seat for the carbon electrode. A spring in the holder yieldably urges the shoe to its electrode-seating position for constant contact with a carbon electrode being removed from or replaced in the holder. The free end of a hand screw engages the contact shoe to move it to seating position thus locking the carbon electrode in the holder. The contact shoe is rockably mounted in the holder about its region of engagement with the free end of the screw.

* *

Metal-Cleaning Agent

2,408,155. SYDNEY G. THORNBURY, Los Angeles, Calif., assigned to TURCO PRODUCTS, INC., Los Angeles. Filed September 17, 1943. Issued September 24, 1946.

A composition for removing oil, grease, and oxides from metal, and depositing a metallic phosphate coating on the clean surface. The cleaning solution consists of water, phosphoric acid, aromatic petroleum solvent, and a coupling agent comprising, by weight, 25-33% of butanol and 21-29% of ethanol.